

# Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/EP05/002307

International filing date: 04 March 2005 (04.03.2005)

Document type: Certified copy of priority document

Document details: Country/Office: GB  
Number: 0405033.2  
Filing date: 05 March 2004 (05.03.2004)

Date of receipt at the International Bureau: 01 April 2005 (01.04.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)



World Intellectual Property Organization (WIPO) - Geneva, Switzerland  
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse



PCT/EP200 5 / 0 0 2 3 0 7

18.03.2005



INVESTOR IN PEOPLE

The Patent Office  
Concept House  
Cardiff Road  
Newport  
South Wales  
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

*Stephen Hordley*

Dated

3 March 2005



Patents Form 1/77

Patents Act 1977  
(Rule 16)

**Request for grant of a patent**

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)



GBHAR04 E878782-1 000001  
P01/7700 0.00-0405033.2 CHEQUE

The Patent Office

Cardiff Road  
Newport  
South Wales  
NP10 8QQ

1. Your reference 10051 GB PAB

2. Patent application number  
(The Patent Office will fill this part in)

0405033.2

05 MAR 2004

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Karo Bio AB  
Novum  
S-141 57 Huddinge  
Sweden

Patents ADP number (*if you know it*)

6477871002

If the applicant is a corporate body, give the country/state of its incorporation

Sweden

4. Title of the invention NOVEL PHARMACEUTICAL COMPOSITIONS

5. Name of your agent (*if you have one*)

Abel & Imray

"Address for service" in the United Kingdom to which all correspondence should be sent  
(including the postcode)

20 Red Lion Street  
London  
WC1R 4PQ  
United Kingdom

Patents ADP number (*if you know it*)

174001

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

Country

Priority application number  
(*if you know it*)

Date of filing  
(*day / month / year*)

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note d)

Number of earlier UK application

Date of filing  
(*day / month / year*)

8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request?

YES

Answer YES if:

- a) any applicant named in part 3 is not an inventor, or
  - b) there is an inventor who is not named as an applicant, or
  - c) any named applicant is a corporate body.
- Otherwise answer NO (See note d)

Patents Form 1/77

## Patents Form 1/77

9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form -

Description 54 ✓

Claim(s) 12 ✓

Abstract 1 ✓

Drawing(s) -

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for a preliminary examination and search (Patents Form 9/77)

Request for a substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature(s)

*Abel & Imray*  
Abel & Imray

Date 5 March 2004

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom
- Paul Brady - 020 7242 9984  
paul.brady@patentable.co.uk

### Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

### Notes

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- If you have answered YES in part 8, a Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.
- Part 7 should only be completed when a divisional application is being made under section 15(4), or when an application is being made under section 8(3), 12(6) or 37(4) following an entitlement dispute. By completing part 7 you are requesting that this application takes the same filing date as an earlier UK application. If you want the new application to have the same priority date(s) as the earlier UK application, you should also complete part 6 with the priority details.

## Novel Pharmaceutical Compositions

### Field of the invention

The present invention relates to compounds which are antagonists or partial antagonists  
5 of the androgen receptor and the use of such compounds for therapeutic purposes

### Background of the invention

The androgen receptor (AR) is a member of the steroid hormone nuclear receptor family  
of ligand activated transcription factors. The family includes estrogen, progesterone,  
10 mineralocorticoid, and glucocorticoid receptors, all of which are activated by endogenous  
steroid hormones to control the expression of responsive genes. The hormone receptors  
share a modular structure consisting of a variable amino-terminal domain (NTD), a  
highly conserved DNA-binding domain (DBD), and a carboxy-terminal ligand-binding  
domain (LBD). The DNA-binding domain generates much of the transcriptional  
15 specificity due to its ability to discern different DNA response elements with the  
promoter regions of target genes. The LBD is required for ligand-dependent  
transcriptional activity and it contains both the hormone-binding pocket and an important  
transcriptional activation functional region (AF2) required for recruitment of coactivators  
and the cellular transcriptional machinery.

20

Nuclear receptor activity is regulation predominantly by the binding of the hormone  
ligand within the LBD. The amino acids lining the interior of the hormone-binding  
cavity define the selectivity of the receptor for its hormone. This allows the AR to  
discriminate between the natural ligands and non-natural ligands.

25

The natural ligand for the androgen receptor, androgen, is produced in both men and  
women by the gonads, adrenal glands and locally in target tissues. The levels of  
androgens secreted by the gonads are tightly regulated by a feedback mechanism  
involving the hypothalamus and pituitary.

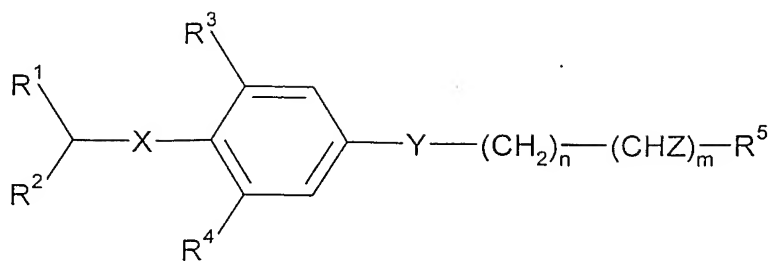
30

In men, androgens are necessary for masculinization and fertility. However, systemic androgen excess causes testicular atrophy and infertility. Androgens may also contribute to cardiovascular disease and psychological abnormalities. Local androgen excess is implicated in the pathogenesis of male pattern baldness (alopecia), benign prostatic hyperplasia (BPH) and acne. The physiological role of androgens in women is not well understood, but they have been found to play a role in the development of normal body hair and libido. In women, relative androgen excess causes hirsutism (excessive hair growth), amenorrhea (abnormal loss or suppression of menses), acne and male pattern baldness.

The risk of developing prostate cancer increases dramatically with age. More than 75% of prostate cancer diagnoses are in men over the age of 65, and the prevalence of clinically undetectable prostate cancer in men over 80 years old is as high as 80%. The exact cause of prostate cancer remains unclear. It is, however, widely accepted that androgens can increase the severity and the rate of progression of the disease. Androgen deprivation therapy has been the basis for prostate cancer therapy since 1941 when castration was shown to have beneficial effects on advanced stages of the disease. Hormonal intervention is currently based on disrupting the hypothalamus-pituitary-gonadal feedback mechanism to control the levels of endogenous androgens from the testes. Antiandrogens are incorporated in later stage therapies to work at the level of the androgen receptor itself, blocking residual androgens from adrenal sources. In spite of these treatments, there exists a need for an improved therapy of diseases linked to disturbances in the activity of the androgen receptor.

### **Summary of the invention**

The present invention provides a compound of formula (I) or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt, for use in the treatment or prophylaxis of a condition mediated by an androgen receptor,



(I)

wherein:

- 5  $\text{R}^1$  is selected from  $\text{C}_{5-10}$  aryl,  $\text{C}(\text{O})\text{-C}_{5-10}$  aryl,  $\text{C}(\text{O})\text{-C}_{3-8}$  heterocyclyl,  $\text{C}_{5-10}$  ar- $\text{C}_{1-2}$  alkyl,  $\text{C}_{3-10}$  heterocyclyl,  $\text{C}_{3-10}$  heterocyclyl- $\text{C}_{1-2}$  alkyl,  $\text{C}_{3-15}$  alkyl,  $\text{C}_{4-15}$  alkenyl,  $\text{C}_{3-15}$  alkynyl,  $\text{C}_{3-10}$  cycloalkyl and  $\text{C}_{3-10}$ cycloalkyl $\text{C}_{1-2}$ alkyl, said alkyl, alkenyl and alkynyl optionally being substituted with, where applicable, 1 to 3 groups  $\text{R}^a$  which may be the same or different; said aralkyl, heterocyclyl and cycloalkyl optionally being substituted with,
- 10 where applicable, 1 to 3 groups  $\text{R}^{a'}$  which may be the same or different; said aryl optionally being substituted with, where applicable, 1 to 4 groups  $\text{R}^{a''}$  which may be the same or different;

$\text{R}^2$  is selected from hydrogen,  $\text{C}_{1-4}$  alkyl,  $\text{C}_{2-4}$  alkenyl,  $\text{C}_{2-4}$  alkynyl and  $\text{C}_{1-4}$  alkoxy;

15

or  $\text{R}^1$  and  $\text{R}^2$  together with the carbon atom to which they are both attached form a  $\text{C}_{4-8}$  cycloalkyl,  $\text{C}_{4-8}$  cycloalkenyl, a saturated or partially saturated  $\text{C}_{3-10}$  heterocyclyl, optionally substituted with, where applicable, 1 to 3 groups  $\text{R}^{a'}$  which may be the same or different;

20

X is selected from  $\text{CH}_2$ , oxygen, sulfur, sulfoxide, sulfone, selenium, tellurium, disulfide, and a group of formula  $\text{-N}(\text{R}^c)\text{-}$ ;

- $\text{R}^3$  and  $\text{R}^4$  are independently selected from hydrogen, halogen,  $\text{C}_{1-4}$  alkyl,  $\text{C}_{3-7}$  cycloalkyl,  $\text{C}_{3-7}$  heterocyclyl,  $\text{C}_{2-4}$  alkenyl,  $\text{C}_{2-4}$  alkynyl,  $\text{C}_{1-4}$  alkoxy, fluoromethyl, difluoromethyl,
- 25



trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio, and COOR<sup>c</sup>;

Y is selected from bond, carbonyl, oxygen, sulphur, -CH(R<sup>b</sup>)-, -NHCO-, -NHSO<sub>2</sub>-,  
5 -SO<sub>2</sub>NH-, -N(R<sup>c</sup>)- and -CR<sup>6</sup>=CR<sup>7</sup>-;

n is an integer selected from 0, 1, 2 and 3;

Z is selected from halogen, amino, hydroxy, mercapto, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub>  
10 alkynyl, C<sub>1-4</sub> alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy and (CH<sub>2</sub>)<sub>p</sub>OH, where p is an integer from 1 to 4;

m is an integer selected from 0 and 1;

15 R<sup>5</sup> is selected from -CO<sub>2</sub>R<sup>c</sup>, -PO(OR<sup>c</sup>)<sub>2</sub>, -PO(OR<sup>c</sup>)NH<sub>2</sub>, -SO<sub>2</sub>OR<sup>c</sup>, -COCO<sub>2</sub>R<sup>c</sup>,  
CONR<sup>c</sup>OR<sup>c</sup>, -SO<sub>2</sub>NHR<sup>c</sup>, -NHSO<sub>2</sub>R<sup>c</sup>, -CONHSO<sub>2</sub>R<sup>c</sup>, and -SO<sub>2</sub>NHCOR<sup>c</sup>;

R<sup>6</sup> and R<sup>7</sup> are independently selected from hydrogen, halogen, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub>  
alkynyl, C<sub>1-4</sub> alkoxy, C<sub>5-10</sub>aryl, fluoromethyl, difluoromethyl, trifluoromethyl,  
20 fluoromethoxy, difluoromethoxy, trifluoromethoxy, and (CH<sub>2</sub>)<sub>p</sub>OH, where p is an integer  
from 1 to 4;

R<sup>a</sup> is selected from halogen, C<sub>1-4</sub> alkoxy, C<sub>5-10</sub>aryl, fluoromethoxy, difluoromethoxy,  
trifluoromethoxy, methylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio,  
25 mercapto, cyano, and nitro;

R<sup>a'</sup> is selected from R<sup>a</sup>, fluoromethyl, difluoromethyl, trifluoromethyl, C<sub>1-4</sub> alkyl, and C<sub>3-10</sub>  
heterocyclyl-C<sub>2-4</sub> alkenyl;

30 R<sup>a''</sup> is selected from:

- R<sup>a'</sup>;

- C<sub>2-4</sub> alkenyl, optionally substituted with 1, 2 or 3 groups selected from C<sub>5-10</sub> aryl, C(O)R<sup>c</sup>, C<sub>3-10</sub> heterocyclyl, and C<sub>3-10</sub> heterocyclyl substituted with C<sub>1-4</sub> alkyl;
- C<sub>2-8</sub> alkenyloxy;
- C<sub>3-8</sub> cycloalkyl-C<sub>1-3</sub> alkoxy, C<sub>5-10</sub> aryl-C<sub>1-3</sub> alkoxy, or C<sub>5-10</sub> aryloxy, said C<sub>3-8</sub> cycloalkyl-C<sub>1-3</sub> alkoxy, C<sub>5-10</sub> aryl-C<sub>1-3</sub> alkoxy or C<sub>5-10</sub> aryloxy optionally being substituted with 1, 2 or 3 groups selected from C<sub>1-4</sub> alkyl, halogen, fluoromethyl, difluoromethyl, trifluoromethyl fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, mercapto, hydroxy, cyano, nitro, a group of formula -N(R<sup>c</sup>)<sub>2</sub> in which the two R<sup>c</sup> groups may be the same or different but not both simultaneously hydrogen;

R<sup>b</sup> is selected from hydrogen, halogen, hydroxyl, mercapto, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub> alkynyl, C<sub>1-4</sub> alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy and (CH<sub>2</sub>)<sub>p</sub>OH, where p is an integer from 1 to 4; and

R<sup>c</sup> is selected from hydrogen, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl and C<sub>2-4</sub> alkynyl; and

R<sup>c'</sup> is selected from R<sup>c</sup>, C<sub>5-10</sub> aryl or C<sub>5-10</sub> aryl substituted with amino, hydroxyl, halogen or C<sub>1-4</sub> alkyl.

Compounds of the invention have surprisingly been found to be antagonists or partial antagonists of the androgen receptor.

#### Detailed description of the invention

The compounds of formula (I) may contain chiral (asymmetric) centres. The individual stereoisomers (enantiomers and diastereoisomers) and mixtures of these are within the scope of the present invention.

Preferably, R<sup>1</sup> is selected from C<sub>5-10</sub> aryl, C(O)-C<sub>5-10</sub> aryl, C(O)-C<sub>3-8</sub> heterocyclyl, C<sub>3-10</sub> heterocyclyl, C<sub>5-10</sub> heterocyclyl-C<sub>1-2</sub>-alkyl, C<sub>3-15</sub> alkyl and C<sub>4-8</sub> cycloalkyl, said alkyl optionally being substituted with, where applicable 1 to 3 groups R<sup>a</sup> which may be the

same or different; said heterocyclyl and cycloalkyl optionally being substituted with, where applicable, 1 to 3 groups  $R^{a'}$  which may be the same or different which may be the same or different; said aryl optionally being substituted with, where applicable, 1 to 4 groups  $R^{a''}$  which may be the same or different which may be the same or different.

5

More preferably,  $R^1$  is selected from  $C_{6-10}$  aryl,  $C(O)-C_{6-10}$  aryl,  $C(O)-C_{3-8}$  heterocyclyl  $C_{5-10}$  heterocyclyl- $C_{1-2}$ -alkyl,  $C_{4-10}$  alkyl and  $C_{5-7}$  cycloalkyl, said alkyl optionally being substituted with, where applicable 1 to 3 groups  $R^a$  which may be the same or different; said heterocyclyl and cycloalkyl optionally being substituted with, where applicable, 1 to 3 groups  $R^{a'}$  which may be the same or different which may be the same or different; said aryl optionally being substituted with, where applicable, 1 to 4 groups  $R^{a''}$  which may be the same or different which may be the same or different.

More preferably,  $R^1$  is selected from phenyl or branched  $C_{4-10}$  alkyl, said alkyl optionally being substituted with, where applicable 1 to 3 groups  $R^a$  which may be the same or different, said phenyl optionally being substituted with, where applicable, 1 to 3 groups  $R^{a''}$  which may be the same or different.

Most preferably,  $R^1$  is phenyl, preferably substituted with 1, 2 or 3 groups  $R^{a''}$  which may be the same or different.

In a particularly preferred embodiment,  $R^1$  is phenyl, substituted with three methyl groups in the 2, 4 and 6 positions. In an alternative preferred embodiment,  $R^1$  is phenyl, substituted with a difluoromethoxy or a trifluoromethoxy group in the 2 position.

25

$R^2$  is preferably selected from hydrogen,  $C_{1-2}$  alkyl,  $C_{2-3}$  alkenyl,  $C_{2-3}$  alkynyl and  $C_{1-2}$  alkoxy.

More preferably,  $R^2$  is selected from hydrogen, methyl or methoxy. Most preferably,  $R^2$  is hydrogen.

30

In an alternative preferred embodiment,  $R^1$  and  $R^2$  together with the carbon atom to which they are both attached form a  $C_{4-8}$  cycloalkyl group or a saturated  $C_{3-8}$  heterocyclyl group, optionally substituted with, where applicable, 1 to 3 groups  $R^a$  which may be the same or different. In such an embodiment, preferably,  $R^1$  and  $R^2$  together with the carbon atom to which they are both attached form a  $C_{5-7}$  cycloalkyl group or a saturated  $C_{3-6}$  heterocyclyl group, most preferably, a cyclohexyl or a tetrahydrofuranyl group.

Preferably, X is selected from oxygen, sulfur and sulfoxide. More preferably, X is sulfur or oxygen, most preferably oxygen.

10

$R^3$  and  $R^4$  are preferably independently selected from hydrogen, halogen,  $C_{1-2}$  alkyl,  $C_{1-2}$  alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy and trifluoromethoxy. More preferably  $R^3$  and  $R^4$  are independently selected from halogen,  $C_{1-2}$  alkyl,  $C_{1-2}$  alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy and trifluoromethoxy.

15

More preferably,  $R^3$  and  $R^4$  are preferably independently selected from halogen and  $C_{1-2}$  alkoxy. Amongst the halogens, there are preferred bromine, chlorine and fluorine, especially bromine and chlorine, in particular bromine.

20

$R^3$  and  $R^4$  may simultaneously represent the same radical. Alternatively,  $R^3$  and  $R^4$  are different from each other. It is preferred that  $R^3$  and  $R^4$  are not both simultaneously hydrogen. In an alternative embodiment,  $R^3$  and  $R^4$  are both simultaneously hydrogen.

25

Y is preferably selected from oxygen, carbonyl and  $-CH(R^b)-$ . Most preferably Y is selected from carbonyl and  $CH_2$ .

n is preferably 0, 1 or 2; more preferably, n is 0 or 1, for example 1.

30

When  $m=1$ , Z is preferably selected from halogen and hydroxy. More preferably, Z is bromine, chlorine or hydroxyl.

Alternatively, m may be 0.

5  $R^5$  is preferably selected from  $-\text{CO}_2R^c$ ,  $-\text{PO}(\text{OR}^c)_2$ ,  $-\text{SO}_2\text{OR}^c$ ,  $-\text{NH}\text{SO}_2R^c$ ,  $-\text{COCO}_2R^c$  and  $\text{CONR}^c\text{OR}^c$ . More preferably,  $R^5$  is  $-\text{CO}_2R^c$ ,  $-\text{PO}(\text{OR}^c)_2$  or  $-\text{SO}_2\text{OR}^c$ . Most preferably,  $R^5$  is  $-\text{CO}_2R^c$ , particularly  $-\text{CO}_2\text{H}$ .

10  $R^6$  and  $R^7$  are preferably independently selected from hydrogen,  $\text{C}_{1-4}$  alkyl,  $\text{C}_{2-4}$  alkenyl and  $\text{C}_{1-4}$  alkoxy. More preferably,  $R^6$  and  $R^7$  are independently selected from hydrogen, methyl and methoxy. Most preferably  $R^6$  and  $R^7$  are hydrogen.

15 When  $R^a$  or  $R^{a'}$  is a halogen, it is preferably selected from bromine, chlorine and fluorine, especially bromine. Substitution with two or three halogen groups is, in some circumstances, preferred. When the basic structure of  $R^1$  includes a  $\text{CH}_3$  or  $\text{OCH}_3$  group, appropriate substitution of that group may lead to a difluoromethyl, a trifluoromethyl, a difluoromethoxy or a trifluoromethoxy group being present in the molecule.

20 Other preferred selections for  $R^a$  are fluoromethoxy, difluoromethoxy, trifluoromethoxy and hydroxyl groups. More preferably,  $R^a$  is selected from difluoromethoxy and trifluoromethoxy.

$R^{a'}$  is preferably  $R^a$  or  $\text{C}_{1-4}$  alkyl, fluoromethyl, difluoromethyl, trifluoromethyl. Most preferably,  $R^{a'}$  is  $R^a$ ,  $\text{C}_{1-2}$  alkyl or trifluoromethyl.

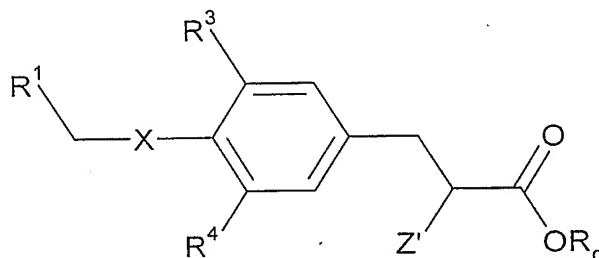
25  $R^{a''}$  is preferably  $R^{a'}$ .

When  $R^1$  includes an aryl group, there are preferably 1 to 3 groups  $R^{a''}$  present in the molecule.

$R^b$  is preferably selected from hydrogen,  $C_{1-4}$  alkyl, fluoromethyl, difluoromethyl and trifluoromethyl. More preferably,  $R^b$  is selected from hydrogen and  $C_{1-2}$  alkyl. Most preferably,  $R^b$  is hydrogen.

- 5  $R^c$  is preferably selected from hydrogen and  $C_{1-2}$  alkyl. More preferably,  $R^c$  is selected from hydrogen and methyl, particularly hydrogen.

Accordingly, one preferred group of compounds of the invention includes compounds according to formula (Ia) or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt



(Ia)

wherein:

- $R^1$  is selected from  $C_{6-10}$  aryl,  $C_{5-10}$  heterocyclyl- $C_{1-2}$ -alkyl,  $C_{4-10}$  alkyl and  $C_{5-7}$  cycloalkyl, said alkyl optionally being substituted with, where applicable, 1 to 3 groups  $R^a$  which may be the same or different; said cycloalkyl optionally being substituted with, where applicable, 1 to 3 groups  $R^{a'}$  which may be the same or different; and said aryl optionally being substituted with, where applicable, 1 to 3 groups  $R^{a''}$  which may be the same or different;
- 25  $X$  is selected from oxygen and sulfur;

$R^3$  and  $R^4$  are independently selected from hydrogen, halogen,  $C_{1-2}$  alkyl,  $C_{1-2}$  alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy and trifluoromethoxy;

5  $Z'$  is selected from hydrogen, halogen, hydroxyl and mercapto;

$R^a$  is selected from halogen,  $C_{5-10}$ aryl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, nitro, and  $C_{1-4}$  alkyl or  $C_{2-4}$  alkenyl substituted with a  $C_{5-10}$  aryl or a  $C_{5-10}$  heterocyclyl group;

10

$R^{a'}$  is selected from  $R^a$ , fluoromethyl, difluoromethyl, trifluoromethyl,  $C_{1-4}$  alkyl and  $C_{5-10}$  heterocyclyl- $C_{2-4}$  alkenyl;

$R^{a''}$  is selected from:

- $R^{a'}$ ;
- 15 -  $C_{2-4}$  alkenyl, substituted with  $C_{3-10}$  heterocyclyl;
- $C_{5-10}$  aryloxy, optionally being substituted with 1, 2 or 3 groups selected from  $C_{1-4}$  alkyl, halogen, fluoromethyl, difluoromethyl, trifluoromethyl fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, mercapto, hydroxy, cyano, or nitro;

20 and

$R^c$  is selected from hydrogen and  $C_{1-4}$  alkyl.

Preferred compounds according to the invention are:

- 25 1: (3,5-dibromo-4-*sec*-butoxyphenyl)acetic acid
- 2: (3,5-dibromo-4-isobutoxyphenyl)acetic acid
- 3: [3,5-dibromo-4-(pentyloxy)phenyl]acetic acid
- 4: [3,5-dibromo-4-(3-methylbutoxy)phenyl]acetic acid
- 5: [3,5-dibromo-4-(hexyloxy)phenyl]acetic acid
- 30 6: [3,5-dibromo-4-(2-ethylbutoxy)phenyl]acetic acid
- 7: [3,5-dibromo-4-(cyclohexylmethoxy)phenyl]acetic acid

- 8: 3-(3,5-dibromo-4-*sec*-butoxyphenyl)propanoic acid  
9: 3-[3,5-dibromo-4-(pentyloxy)phenyl]propanoic acid  
10: 3-[3,5-dibromo-4-(hexyloxy)phenyl]propanoic acid  
11: 3-[3,5-dibromo-4-(3-methylbutoxy)phenyl]propanoic acid  
5 12: 3-[3,5-dibromo-4-(2-ethylbutoxy)phenyl]propanoic acid  
13: 3-[3,5-dibromo-4-(cyclohexylmethoxy)phenyl]propanoic acid  
14: 3-[3,5-dibromo-4-(3-cyclohexylpropoxy)phenyl]propanoic acid  
15: 3-{3,5-dibromo-4-[(3-methylbenzyl)oxy]phenyl}propanoic acid  
16: 3-{3,5-dibromo-4-[(2*Z*)-pent-2-en-1-yloxy]phenyl}propanoic acid  
10 17: 3-{3,5-dibromo-4-[(3-methylbenzyl)oxy]phenyl}propanoic acid  
18: 3-[3,5-dibromo-4-(pent-4-en-1-yloxy)phenyl]propanoic acid  
19: 3-[3,5-dibromo-4-(but-2-yn-1-yloxy)phenyl]propanoic acid  
20: (3,5-dibromo-4-butoxyphenyl)acetic acid  
21: 3-{3,5-dibromo-4-[(3-methylbenzyl)oxy]phenyl}acetic acid  
15 22: 3-(3,5-dibromo-4-{[3-(trifluoromethyl)benzyl]oxy}phenyl)propanoic acid  
23: 3-{3,5-dibromo-4-[(3-bromobenzyl)oxy]phenyl}propanoic acid  
24: 3-{3,5-dibromo-4-[(2-methylbenzyl)oxy]phenyl}propanoic acid  
25: 3-{3,5-dibromo-4-[(4-methylbenzyl)oxy]phenyl}propanoic acid  
26: 3-{3,5-dibromo-4-[(3,5-dimethylbenzyl)oxy]phenyl}propanoic acid  
20 27: 3-{3,5-dibromo-4-[(4-fluorobenzyl)oxy]phenyl}propanoic acid  
28: 3-(3,5-dibromo-4-{[4-(trifluoromethyl)benzyl]oxy}phenyl)propanoic acid  
29: 3-{3,5-dibromo-4-[(3-nitrobenzyl)oxy]phenyl}propanoic acid  
30: 3-{3,5-dibromo-4-[(4-*tert*-butylbenzyl)oxy]phenyl}propanoic acid  
31: *N*-[3,5-Dibromo-4-(3-bromobenzyloxy)benzoyl]benzenesulphonamide  
25 32: *N*-[3,5-Dibromo-4-(3-bromobenzyloxy)benzoyl]-3-nitrobenzenesulphonamide  
33: *N*-[3,5-Dibromo-4-(3-bromobenzyloxy)benzoyl]-4-nitrobenzenesulphonamide  
34: 4-Amino-*N*-[3,5-dibromo-4-(3-bromobenzyloxy)benzoyl]benzenesulphonamide  
35: *N*-[3,5-Dibromo-4-(3-bromobenzyloxy)benzoyl]methanesulphonamide  
36: {3,5-dibromo-4-[(2-ethylhexyl)oxy]phenyl}acetic acid  
30 37: [3,5-dibromo-4-(cyclopropylmethoxy)phenyl]acetic acid  
38: 3-[3,5-dibromo-4-(2-naphthylmethoxy)phenyl]propanoic acid



- 39: 3-{3,5-dibromo-4-[(3,5-dibromobenzyl)oxy]phenyl}propanoic acid  
40: 3-{3,5-dibromo-4-[(3-cyanobenzyl)oxy]phenyl}propanoic acid  
41: 3-{3,5-dibromo-4-[(3-methoxybenzyl)oxy]phenyl}propanoic acid  
42: (4-butoxy-3,5-dichlorophenyl)(hydroxy)acetic acid  
5 43: [3,5-dichloro-4-(heptyloxy)phenyl](hydroxy)acetic acid  
44: {4-[(3-bromobenzyl)oxy]-3,5-dichlorophenyl}(hydroxy)acetic acid  
45: (4-butoxy-3,5-dichlorophenyl)(oxo)acetic acid  
46: [3,5-dichloro-4-(heptyloxy)phenyl](oxo)acetic acid  
47: {4-[(3-bromobenzyl)oxy]-3,5-dichlorophenyl}(oxo)acetic acid  
10 48: {3,5-dichloro-4-[(3,5-dimethylbenzyl)oxy]phenyl}(oxo)acetic acid  
49: {3,5-dichloro-4-[(3-methoxybenzyl)oxy]phenyl}(oxo)acetic acid  
50: (4-butoxy-3,5-dimethylphenyl)acetic acid  
51: [4-(cyclohexylmethoxy)-3,5-dimethylphenyl]acetic acid  
52: [4-(heptyloxy)-3,5-dimethylphenyl]acetic acid  
15 53: {4-[(3-bromobenzyl)oxy]-3,5-dimethylphenyl}acetic acid  
54: {4-[(3,5-dimethylbenzyl)oxy]-3,5-dimethylphenyl}acetic acid  
55: {4-[(3-methoxybenzyl)oxy]-3,5-dimethylphenyl}acetic acid  
56: (4-butoxy-3,5-dimethylphenyl)(oxo)acetic acid  
57: [4-(heptyloxy)-3,5-dimethylphenyl](oxo)acetic acid  
20 58: {4-[(3-bromobenzyl)oxy]-3,5-dimethylphenyl}(oxo)acetic acid  
59: {4-[(3,5-dimethylbenzyl)oxy]-3,5-dimethylphenyl}(oxo)acetic acid  
60: {4-[(3-methoxybenzyl)oxy]-3,5-dimethylphenyl}(oxo)acetic acid  
61: (4-butoxy-3,5-diisopropylphenyl)(oxo)acetic acid  
62: {4-[(2-ethylhexyl)oxy]-3,5-diisopropylphenyl}(oxo)acetic acid  
25 63: [4-(cyclohexylmethoxy)-3,5-diisopropylphenyl](oxo)acetic acid  
64: [4-(heptyloxy)-3,5-diisopropylphenyl](oxo)acetic acid  
65: {4-[(3-bromobenzyl)oxy]-3,5-diisopropylphenyl}(oxo)acetic acid  
66: {4-[(3,5-dimethylbenzyl)oxy]-3,5-diisopropylphenyl}(oxo)acetic acid  
67: {3,5-diisopropyl-4-[(3-methoxybenzyl)oxy]phenyl}(oxo)acetic acid  
30 68: (4-butoxy-3,5-diisopropylphenyl)acetic acid  
69: {4-[(3-bromobenzyl)oxy]-3,5-diisopropylphenyl}acetic acid

- 70: {4-[(3,5-dimethylbenzyl)oxy]-3,5-diisopropylphenyl}acetic acid  
71: {3,5-diisopropyl-4-[(3-methoxybenzyl)oxy]phenyl}acetic acid  
72: 3-(3,5-dibromo-4-{[3-(trifluoromethoxy)benzyl]oxy}phenyl)propanoic acid  
73: 3-(3,5-dibromo-4-{[3-fluoro-5-(trifluoromethyl)benzyl]oxy}phenyl)propanoic acid  
5 74: 3-{3,5-dibromo-4-[(3-fluorobenzyl)oxy]phenyl}propanoic acid  
75: 3-{3,5-dibromo-4-[(3,5-difluorobenzyl)oxy]phenyl}propanoic acid  
76: 3-(4-{[3,5-bis(trifluoromethyl)benzyl]oxy}-3,5-dibromophenyl)propanoic acid  
77: 3-(3,5-dibromo-4-{[3-(difluoromethoxy)benzyl]oxy}phenyl)propanoic acid  
78: 3-[3,5-dibromo-4-(1-naphthylmethoxy)phenyl]propanoic acid  
10 79: 3-[3,5-dibromo-4-(pyridin-2-ylmethoxy)phenyl]propanoic acid  
80: 3-[3,5-dibromo-4-(pyridin-3-ylmethoxy)phenyl]propanoic acid  
81: 3-[3,5-dibromo-4-(pyridin-4-ylmethoxy)phenyl]propanoic acid  
82: 3-[3,5-dibromo-4-(quinolin-2-ylmethoxy)phenyl]propanoic acid  
83: 3-{3,5-dibromo-4-[(5-chloro-1-benzothien-3-yl)methoxy]phenyl}propanoic acid  
15 84: 3-(3,5-dibromo-4-{[4-chloro-2-(trifluoromethyl)quinolin-6-yl]methoxy}phenyl)-  
propanoic acid  
85: 3-{3,5-dibromo-4-[(5-methylisoxazol-3-yl)methoxy]phenyl}propanoic acid  
86: 3-{3,5-dibromo-4-[(3,5-dichlorobenzyl)oxy]phenyl}propanoic acid  
87: 3-{3,5-dibromo-4-[(2-fluorobenzyl)oxy]phenyl}propanoic acid  
20 88: 3-[3,5-dibromo-4-(mesitylmethoxy)phenyl]propanoic acid  
89: 3-{3,5-dibromo-4-[(2-methyl-1,3-thiazol-4-yl)methoxy]phenyl}propanoic acid  
90: 3-{3,5-dibromo-4-[(3-chlorobenzyl)oxy]phenyl}propanoic acid  
91: 3-{3,5-dibromo-4-[(2-chlorobenzyl)oxy]phenyl}propanoic acid  
92: 3-{3,5-dibromo-4-[(3-iodobenzyl)oxy]phenyl}propanoic acid  
25 93: 3-[3,5-dibromo-4-(tetrahydro-2H-pyran-2-ylmethoxy)phenyl]propanoic acid  
94: 3-{3,5-dibromo-4-[(2-nitrobenzyl)oxy]phenyl}propanoic acid  
95: 3-(3,5-dibromo-4-{[2-(difluoromethoxy)benzyl]oxy}phenyl)propanoic acid  
96: 3-(3,5-dibromo-4-{[2-(trifluoromethoxy)benzyl]oxy}phenyl)propanoic acid  
97: 3-{3,5-dibromo-4-[(1-bromo-6-fluoro-2-naphthyl)methoxy]phenyl}propanoic acid  
30 98: 3-(3,5-dibromo-4-{[2-(trifluoromethyl)benzyl]oxy}phenyl)propanoic acid  
99: 3-{3,5-dibromo-4-[(1-bromo-2-naphthyl)methoxy]phenyl}propanoic acid

- 100: 3-{3,5-dibromo-4-[(6-methoxy-2-naphthyl)methoxy]phenyl}propanoic acid  
101: 3-[3,5-dibromo-4-(3-ethoxybenzyloxy)phenyl]propionic acid  
102: 3-[3,5-dibromo-4-(3-propyloxybenzyloxy)phenyl]propionic acid  
103: 3-[3,5-dibromo-4-(3-butyloxybenzyloxy)phenyl]propionic acid  
5 104: 3-[3,5-dibromo-4-(3-aminobenzyloxy)phenyl]propionic acid  
106: 3-[3,5-dibromo-4-(3-diethylaminebenzyloxy)phenyl]propionic acid  
107: N-[3,5-Dibromo-4-(3-bromobenzyloxy)phenyl]oxamic acid  
108: N-[3,5-Dibromo-4-(2-methylnaphthyloxy)phenyl]oxamic acid  
109: 3-[3-bromo-5-methoxy-4-(3-bromobenzyloxy)phenyl]propionic acid  
10 110: 3-[3-bromo-5-methoxy-4-(2-methylnaphthyloxy)phenyl]propionic acid  
111: 3-(3,5-dibromo-4-{[4-(trifluoromethyl)benzyl]oxy}phenyl)acrylic acid  
112: 3-{3,5-dibromo-4-[(2-methylbenzyl)oxy]phenyl}acrylic acid  
113: 3-(3,5-dibromo-4-{[3-(trifluoromethoxy)benzyl]oxy}phenyl)acrylic acid  
114: 3-[3,5-dibromo-4-(pyridin-2-ylmethoxy)phenyl]acrylic acid  
15 115: 3-[3,5-dibromo-4-(quinolin-2-ylmethoxy)phenyl]acrylic acid  
116: 3-(3,5-dibromo-4-{[3-fluoro-5-(trifluoromethyl)benzyl]oxy}phenyl)acrylic acid  
117: 3-{3,5-dibromo-4-[(5-methylisoxazol-3-yl)methoxy]phenyl}acrylic acid  
118: 3-{3,5-dibromo-4-[(3-bromobenzyl)oxy]phenyl}acrylic acid  
119: 3-[3,5-dibromo-4-(2-naphthylmethoxy)phenyl]acrylic acid  
20 120: 3-{3-bromo-4-[(3-bromobenzyl)oxy]-5-methoxyphenyl}acrylic acid  
121: 3-[3-bromo-5-methoxy-4-(2-naphthylmethoxy)phenyl]acrylic acid  
122: 3-{3,5-dibromo-4-[2-(1*H*-indol-3-yl)ethoxy]phenyl}propanoic acid  
123: 3-[4-(biphenyl-2-ylmethoxy)-3,5-dibromophenyl]propanoic acid  
124: 3-{3,5-dibromo-4-[(3-bromobenzyl)oxy]phenyl}-2-hydroxypropanoic acid  
25 125: 2-chloro-3-{3,5-dibromo-4-[(3-bromobenzyl)oxy]phenyl}propanoic acid  
126: 3-[3,5-dibromo-4-({2-[(*E*)-2-pyridin-4-ylvinyl]benzyl}oxy)phenyl]propanoic acid

The following compounds are also preferred:

- 127: 3-(3,5-dibromo-4-{[3-(4-fluorophenoxy)benzyl]oxy}phenyl)propanoic acid  
30 128: 3-(3,5-dibromo-4-{[3-(2-phenyl(*E*)vinyl]benzyl]oxy}phenyl)propanoic acid

- 129: 3-[3,5-dibromo-4-({3-[(*E*)-2-(4-methyl-1,3-thiazol-5-yl)vinyl]benzyl}oxy)phenyl]propanoic acid
- 130: 3-(4-{{3-(3-methylbenzyloxy)benzyl}oxy}-3,5-dibromophenyl)propanoic acid
- 131: 3-[3,5-dibromo-4-(2-naphthylmethoxy)phenyl]-2-hydroxypropanoic acid
- 5 132: 3,5-dibromo-4-[(3-bromobenzyl)oxy]-*N*-(phenylsulfonyl)benzamide
- 133: 3-(3,5-dibromo-4-{{3-(pent-4-en-1-yloxy)benzyl}oxy}phenyl)propanoic acid
- 134: {3,5-dibromo-4-[2-(5,5,8,8-tetramethyl-5,6,7,8-tetrahydronaphthalen-2-yl)-2-oxoethoxy]phenyl}propanoic acid
- 135: 3,5-dibromo-4-[(3-bromobenzyl)oxy]benzoic acid
- 10 136: 3-[3,5-dibromo-4-({3-[(*E*)-2-pyridin-4-ylvinyl]benzyl}oxy)phenyl]propanoic acid
- 137: 3-{3,5-dibromo-4-[2-(3-methyl-1-benzothien-2-yl)-2-oxoethoxy]phenyl}propanoic acid
- 138: 3-{3-bromo-4-[(3-bromobenzyl)oxy]-5-piperidin-1-ylphenyl}propanoic acid
- 139: 3-(3,5-dibromo-4-{{3-(cyclopropylmethoxy)benzyl}oxy}phenyl)propanoic acid
- 15 140: 3-[3,5-dibromo-4-({2-[(1*E*)-2-methyl-3-oxobut-1-en-1-yl]benzyl}oxy)phenyl]propanoic acid
- 141: 3-[3,5-dibromo-4-({3-[(1*E*)-2-methyl-3-oxobut-1-en-1-yl]benzyloxy)phenyl]propanoic acid
- 142: 3,5-dibromo-*O*-(3-bromobenzyl)tyrosine
- 20
- Especially preferred are:
- 11: 3-[3,5-dibromo-4-(3-methylbutoxy)phenyl]propanoic acid
- 13: 3-[3,5-dibromo-4-(cyclohexylmethoxy)phenyl]propanoic acid
- 22: 3-(3,5-dibromo-4-{{3-(trifluoromethyl)benzyl}oxy}phenyl)propanoic acid
- 25 23: 3-{3,5-dibromo-4-[(3-bromobenzyl)oxy]phenyl}propanoic acid
- 24: 3-{3,5-dibromo-4-[(2-methylbenzyl)oxy]phenyl}propanoic acid
- 25: 3-{3,5-dibromo-4-[(4-methylbenzyl)oxy]phenyl}propanoic acid
- 27: 3-{3,5-dibromo-4-[(4-fluorobenzyl)oxy]phenyl}propanoic acid
- 28: 3-(3,5-dibromo-4-{{4-(trifluoromethyl)benzyl}oxy}phenyl)propanoic acid
- 30 39: 3-{3,5-dibromo-4-[(3,5-dibromobenzyl)oxy]phenyl}propanoic acid
- 73: 3-(3,5-dibromo-4-{{3-fluoro-5-(trifluoromethyl)benzyl}oxy}phenyl)propanoic acid

- 76: 3-(4-{[3,5-bis(trifluoromethyl)benzyl]oxy}-3,5-dibromophenyl)propanoic acid  
 77: 3-(3,5-dibromo-4-{[3-(difluoromethoxy)benzyl]oxy}phenyl)propanoic acid  
 78: 3-[3,5-dibromo-4-(1-naphthylmethoxy)phenyl]propanoic acid  
 87: 3-{3,5-dibromo-4-[(2-fluorobenzyl)oxy]phenyl}propanoic acid  
 5 88: 3-[3,5-dibromo-4-(mesitylmethoxy)phenyl]propanoic acid  
 90: 3-{3,5-dibromo-4-[(3-chlorobenzyl)oxy]phenyl}propanoic acid  
 91: 3-{3,5-dibromo-4-[(2-chlorobenzyl)oxy]phenyl}propanoic acid  
 94: 3-{3,5-dibromo-4-[(2-nitrobenzyl)oxy]phenyl}propanoic acid  
 95: 3-(3,5-dibromo-4-{[2-(difluoromethoxy)benzyl]oxy}phenyl)propanoic acid  
 10 96: 3-(3,5-dibromo-4-{[2-(trifluoromethoxy)benzyl]oxy}phenyl)propanoic acid  
 98: 3-(3,5-dibromo-4-{[2-(trifluoromethyl)benzyl]oxy}phenyl)propanoic acid  
 99: 3-{3,5-dibromo-4-[(1-bromo-2-naphthyl)methoxy]phenyl}propanoic acid  
 106: 3-[3,5-dibromo-4-(3-diethylaminebenzyloxy)phenyl]propionic acid  
 122: 3-{3,5-dibromo-4-[2-(1*H*-indol-3-yl)ethoxy]phenyl}propanoic acid  
 15 123: 3-[4-(biphenyl-2-ylmethoxy)-3,5-dibromophenyl]propanoic acid  
 125: 2-chloro-3-{3,5-dibromo-4-[(3-bromobenzyl)oxy]phenyl}propanoic acid  
 126: 3-[3,5-dibromo-4-({2-[(*E*)-2-pyridin-4-ylvinyl]benzyl}oxy)phenyl]propanoic acid

Most preferred are:

- 20 88: 3-[3,5-dibromo-4-(mesitylmethoxy)phenyl]propanoic acid  
 95: 3-(3,5-dibromo-4-{[2-(difluoromethoxy)benzyl]oxy}phenyl)propanoic acid  
 96: 3-(3,5-dibromo-4-{[2-(trifluoromethoxy)benzyl]oxy}phenyl)propanoic acid

- Salts and solvates of compounds of formula (I) which are suitable for use in medicine are  
 25 those wherein a counterion or associated solvent is pharmaceutically acceptable.

However, salts and solvates having non-pharmaceutically acceptable counterions or associated solvents are within the scope of the present invention, for example, for use as intermediates in the preparation of the compounds of formula (I) and their pharmaceutically acceptable salts, solvates and physiologically functional derivatives.

- 30 By the term "physiologically functional derivative" is meant a chemical derivative of a compound of formula (I) having the same physiological function as the free compound of

formula (I), for example, by being convertible in the body thereto. According to the present invention, examples of physiological functional derivatives include esters, amides, and carbamates; preferably esters and amides.

5 Suitable salts according to the invention include those formed with organic or inorganic acids or bases. Pharmaceutically acceptable acid addition salts include those formed from hydrochloric, hydrobromic, sulphuric, nitric, citric, tartaric, acetic, phosphoric, lactic, pyruvic, acetic, trifluoroacetic, succinic, perchloric, fumaric, maleic, glycollic, lactic, salicylic, oxaloacetic, methanesulfonic, ethanesulfonic, p-toluenesulfonic, formic,  
10 benzoic, malonic, naphthalene-2-sulfonic, benzenesulfonic, and isethionic acids. Other acids such as oxalic, while not in themselves pharmaceutically acceptable, may be useful as intermediates in obtaining the compounds of the invention and their pharmaceutical acceptable acid addition salts. Pharmaceutically acceptable base salts include ammonium salts, alkali metal salts, for example those of potassium and sodium, alkaline earth metal  
15 salts, for example those of calcium and magnesium, and salts with organic bases, for example dicyclohexylamine and N-methyl-D-glucamine.

Pharmaceutically acceptable esters and amides of the compounds of formula (I) may have an appropriate group, for example an acid group, converted to a C<sub>1-6</sub> alkyl, C<sub>5-10</sub> aryl,  
20 C<sub>5-10</sub> ar-C<sub>1-6</sub> alkyl, or amino acid ester or amide. Pharmaceutically acceptable amides and carbonates of the compounds of formula (I) may have an appropriate group, for example an amino group, converted to a C<sub>1-6</sub> alkyl, C<sub>5-10</sub> aryl, C<sub>5-10</sub> ar-C<sub>1-6</sub> alkyl, or amino acid ester or amide, or carbamate.

25 Those skilled in the art of organic chemistry will appreciate that many organic compounds can form complexes with solvents in which they are reacted or from which they are precipitated or crystallized. These complexes are known as "solvates". For example, a complex with water is known as a "hydrate".

30 A compound which, upon administration to the recipient, is capable of providing (directly or indirectly) compound of formula (I) as described above or an active metabolite or

residue thereof, is known as a "prodrug". A prodrug may, for example, be converted within the body, e. g. by hydrolysis in the blood, into its active form that has medical effects. Pharmaceutical acceptable prodrugs are described in T. Higuchi and V. Stella, Prodrugs as Novel Delivery Systems, Vol. 14 of the A. C. S. Symposium Series; and in Edward B. Roche, ed., Bioreversible Carriers in Drug Design, American Pharmaceutical Association and Pergamon Press, 1987, both of which are incorporated herein by reference.

10 As used herein, the term "alkyl" means both straight and branched chain saturated hydrocarbon groups. Examples of alkyl groups include methyl, ethyl, n-propyl, iso-propyl, n-butyl, t-butyl, i-butyl, pentyl, hexyl, heptyl, octyl, nonyl and decyl groups. Among unbranched alkyl groups, there are preferred methyl, ethyl, n-propyl, iso-propyl, n-butyl groups. Among branched alkyl groups, there may be mentioned t-butyl, i-butyl,  
15 1-ethylpropyl, 1-ethyl butyl and 1-ethylpentyl groups.

As used herein, the term "alkoxy" means the group O-alkyl, where "alkyl" is used as described above. Examples of alkoxy groups include methoxy and ethoxy groups. Other examples include propoxy and butoxy.

20

As used herein, the term "alkenyl" means both straight and branched chain unsaturated hydrocarbon groups with at least one carbon carbon double bond. Up to 5 carbon carbon double bonds may, for example, be present. Examples of alkenyl groups include ethenyl, propenyl, butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, decenyl and dodecenyl.  
25 Preferred alkenyl groups includes ethenyl, 1- propenyl and 2- propenyl.

As used herein, the term "alkenyloxy" means the group O-alkenyl, where "alkenyl" is used as described above. Examples of alkoxy groups include and ethenoxy groups. Other examples include 2-propenoxy 3-butenoxy and 4-pentenoxo.

30

As used herein, the term "alkynyl" means both straight and branched chain unsaturated hydrocarbon groups with at least one carbon carbon triple bond. Up to 5 carbon carbon triple bonds may, for example, be present. Examples of alkynyl groups include ethynyl, propynyl, butynyl, pentynyl, hexynyl, heptynyl, octynyl, nonynyl, decynyl and dodecynyl. Preferred alkenyl groups include ethynyl 1- propynyl and 2- propynyl.

As used herein, the term "cycloalkyl" means an aliphatic group in a ring system. The cycloalkyl group can be monocyclic or bicyclic. A bicyclic group may, for example, be fused or bridged. Examples of monocyclic cycloalkyl groups include cyclopropyl, cyclobutyl and cyclopentyl. Other examples of monocyclic cycloalkyl groups are cyclohexyl, cycloheptyl and cyclooctyl. Examples of bicyclic cycloalkyl groups include bicyclo [2. 2.1]hept-2-yl. Preferably, the cycloalkyl group is monocyclic.

As used herein, the term "cycloalkenyl" means a partially unsaturated aliphatic group in a ring system. A cycloalkenyl group can be monocyclic or bicyclic. Preferably, the cycloalkyl group is monocyclic. Examples of monocyclic cycloalkenyl groups include cyclopentenyl and cyclohexenyl.

As used herein, the term "aryl" means a monocyclic or bicyclic aromatic carbocyclic group. Examples of aryl groups include phenyl and naphthyl. A naphthyl group may be attached through the 1 or the 2 position. In a bicyclic aromatic group, one of the rings may, for example, be partially saturated. Examples of such groups include indanyl and tetrahydronaphthyl. A particularly preferred aryl group is phenyl.

As used herein, the term "aryloxy" means the group O-aryl, where "aryl" is used as described above.

As used herein, the term "halogen" means fluorine, chlorine, bromine or iodine. Fluorine, chlorine and bromine are particularly preferred.



As used herein, the term "heterocyclyl" means an aromatic ("heteroaryl") or a non-aromatic ("heterocycloalkyl") cyclic group of carbon atoms wherein from one to three of the carbon atoms is/are replaced by a heteroatom independently selected from nitrogen, oxygen or sulfur. A heterocyclyl group may, for example, be monocyclic or bicyclic. In a bicyclic heterocyclyl group there may be one or more heteroatoms in each ring, or only in one of the rings. The heteroatom is preferably O or N. Heterocyclyl groups include the corresponding N-oxides. Examples of heterocyclyl groups include piperidinyl, tetrahydrofuranyl, tetrahydropyranyl, pyridyl, pyrimidyl and indolyl.

As used herein, the term "aralkyl" means a group aryl-alkyl- attached through the alkyl group, "aryl" and "alkyl" being understood to have the meanings outlined above.

As used herein the term "cycloalkylalkyl" means a group cycloalkyl-alkyl- attached through the alkyl group, "cycloalkyl" and "alkyl" being understood to have the meanings outlined above.

As used herein the term "cycloalkylalkoxy" means a group cycloalkyl-alkoxy- attached through the alkoxy group, "cycloalkyl" and "alkoxy" being understood to have the meanings outlined above.

As used herein the term "arylalkoxy" means a group aryl-alkoxy- attached through the alkoxy group, "aryl" and "alkoxy" being understood to have the meanings outlined above.

As used herein, the term "heterocyclylalkyl" means a group heterocyclyl-alkyl- attached through the alkyl group, "heterocyclyl" and "alkyl" being understood to have the meanings outlined above. Similarly, as used herein, the term "heterocyclylalkenyl" means a group heterocyclyl-alkenyl- attached through the alkenyl group, "heterocyclyl" and "alkenyl" being understood to have the meanings outlined above.

As mentioned above, the compounds of the invention have activity as antagonists or partial antagonists of the androgen receptor. Therefore, the compounds have use in the treatment or prophylaxis of clinical conditions for which an antagonist or a partial antagonist of the androgen receptor is indicated. Such conditions include cancers, bone diseases, reproductive diseases and others. In particular, there may be mentioned  
5 prostate cancer, cardiovascular disease and psychological abnormalities, male pattern baldness (alopecia), benign prostatic hyperplasia (BPH) and acne, hirsutism, amenorrhea, hypogonadism, anemia, defects in spermatogenesis, cachexia, osteoporosis, osteopenia, and muscle wasting.

10

The compounds of the invention find particular application in the treatment or prophylaxis of prostate cancer.

Accordingly, the invention also provides a method for the treatment or prophylaxis of a  
15 condition in a mammal mediated by an androgen receptor, which comprises administering to the mammal a therapeutically effective amount of a compound of formula (I) as defined above or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt.

20

The invention also provides the use of a compound of formula (I) as defined above or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt, for the manufacture of a medicament for the treatment or prophylaxis of a condition mediated by an androgen  
25 receptor.

Hereinafter, the term "active ingredient" means a compound of formula (I) as defined above, or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt.

30

The amount of active ingredient which is required to achieve a therapeutic effect will, of course, vary with the particular compound, the route of administration, the subject under treatment, and the particular disorder or disease being treated. The compounds of the invention may be administered orally or via injection at a dose of from 0.1 to 1500 mg/kg per day, preferably 0.1 to 500 mg/kg per day. The dose range for adult humans is generally from 5 mg to 35 g per day and preferably 5 mg to 2 g per day. Tablets or other forms of presentation provided in discrete units may conveniently contain an amount of compound of the invention which is effective at such dosage or as a multiple of the same, for example units containing 5 mg to 500 mg, usually around 10 mg to 200 mg.

While it is possible for the active ingredient to be administered alone, it is preferable for it to be present in a pharmaceutical formulation. Accordingly, the invention provides a pharmaceutical formulation comprising a compound of formula (I) as defined above or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt, and a pharmaceutically acceptable excipient.

The pharmaceutical formulations according to the invention include those suitable for oral, parenteral (including subcutaneous, intradermal, intramuscular, intravenous, and intraarticular), inhalation (including fine particle dusts or mists which may be generated by means of various types of metered dose pressurized aerosols), nebulizers or insufflators, rectal and topical (including dermal, buccal, sublingual, and intraocular) administration, although the most suitable route may depend upon, for example, the condition and disorder of the recipient.

The formulations may conveniently be presented in unit dosage form and may be prepared by any of the methods well known in the art of pharmacy. All methods include the step of bringing the active ingredient into association with the carrier which constitutes one or more accessory ingredients. In general the formulations are prepared by uniformly and intimately bringing into association the active ingredient with liquid

carriers or finely divided solid carriers or both and then, if necessary, shaping the product into the desired formulation.

5 Formulations of the present invention suitable for oral administration may be presented as discrete units such as capsules, cachets or tablets each containing a predetermined amount of the active ingredient; as a powder or granules; as a solution or a suspension in an aqueous liquid or a non-aqueous liquid; or as an oil-in-water liquid emulsion or a water-in-oil liquid emulsion. The active ingredient may also be presented as a bolus, electuary or paste.

10

A tablet may be made by compression or moulding, optionally with one or more accessory ingredients. Compressed tablets may be prepared by compressing in a suitable machine the active ingredient in a free-flowing form such as a powder or granules, optionally mixed with a binder, lubricant, inert diluent, lubricating, surface active or  
15 dispersing agent. Moulded tablets may be made by moulding in a suitable machine a mixture of the powdered compound moistened with an inert liquid diluent. The tablets may optionally be coated or scored and may be formulated so as to provide slow or controlled release of the active ingredient therein.

20 Formulations for parenteral administration include aqueous and non-aqueous sterile injection solutions which may contain anti-oxidants, buffers, bacteriostats and solutes which render the formulation isotonic with the blood of the intended recipient; and aqueous and non-aqueous sterile suspensions which may include suspending agents and thickening agents. The formulations may be presented in unit-dose or multi-dose  
25 containers, for example sealed ampoules and vials, and may be stored in a freeze-dried (lyophilised) condition requiring only the addition of the sterile liquid carrier, for example saline or water-for-injection, immediately prior to use. Extemporaneous injection solutions and suspensions may be prepared from sterile powders, granules and tablets of the kind previously described.

30

Formulations for rectal administration may be presented as a suppository with the usual carriers such as cocoa butter or polyethylene glycol.

Formulations for topical administration in the mouth, for example buccally or  
5 sublingually, include lozenges comprising the active ingredient in a flavoured basis such as sucrose and acacia or tragacanth, and pastilles comprising the active ingredient in a basis such as gelatin and glycerine or sucrose and acacia.

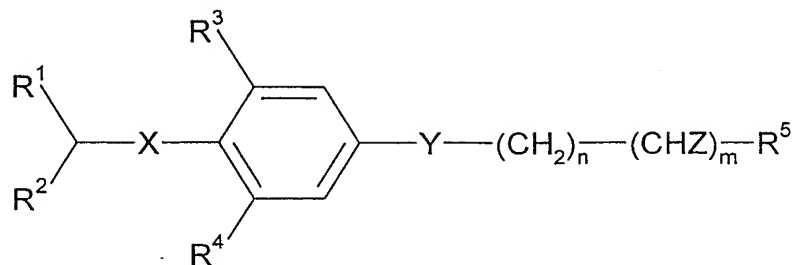
Preferred unit dosage formulations are those containing an effective dose, as hereinbefore  
10 recited, or an appropriate fraction thereof, of the active ingredient.

It should be understood that in addition to the ingredients particularly mentioned above, the formulations of this invention may include other agents conventional in the art having regard to the type of formulation in question, for example those suitable for oral  
15 administration may include flavouring agents.

The compounds of formula (I) as described above also find use, optionally in labelled form, as a diagnostic agent for the diagnosis of conditions associated with malfunction of the androgen receptor. For example, such a compound may be radioactively labelled.  
20

The compounds of formula (I) as described above also find use as a reference compound in methods of discovering other antagonists or partial antagonists of the androgen receptor. For example, such a method may involve a competitive binding experiment in which binding of a compound of formula (I) to the androgen receptor is reduced by the  
25 presence of a further compound which has androgen receptor-binding characteristics, for example stronger androgen receptor-binding characteristics than the compound of formula (I) in question.

In a further aspect, the invention provides a compound of formula (Ib) or a  
30 pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt,



5 wherein:

$R^1$  is selected from  $C_{5-10}$  aryl,  $C(O)-C_{5-10}$  aryl,  $C(O)-C_{3-8}$  heterocyclyl,  $C_{5-10}$  ar- $C_{1-2}$  alkyl,  $C_{3-10}$  heterocyclyl,  $C_{3-10}$  heterocyclyl- $C_{1-2}$  alkyl,  $C_{3-15}$  alkyl,  $C_{4-15}$  alkenyl,  $C_{3-15}$  alkynyl,  $C_{3-10}$  cycloalkyl and  $C_{3-10}$ cycloalkyl- $C_{1-2}$ alkyl, said alkyl, alkenyl and alkynyl optionally being substituted with, where applicable, 1 to 3 groups  $R^a$  which may be the same or  
 10 different; said aralkyl, heterocyclyl and cycloalkyl optionally being substituted with, where applicable, 1 to 3 groups  $R^a$  which may be the same or different; said aryl optionally being substituted with, where applicable, 1 to 4 groups  $R^{a''}$  which may be the same or different;

15  $R^2$  is selected from hydrogen,  $C_{1-4}$  alkyl,  $C_{2-4}$  alkenyl,  $C_{2-4}$  alkynyl and  $C_{1-4}$  alkoxy;

or  $R^1$  and  $R^2$  together with the carbon atom to which they are both attached form a  $C_{4-8}$  cycloalkyl,  $C_{4-8}$  cycloalkenyl, a saturated or partially saturated  $C_{3-10}$  heterocyclyl, optionally substituted with, where applicable, 1 to 3 groups  $R^a$  which may be the same or  
 20 different;

X is selected from  $CH_2$ , oxygen, sulfur, sulfoxide, sulfone, selenium, tellurium, disulfide, and a group of formula  $-N(R^c)-$ ;

25  $R^3$  and  $R^4$  are independently selected from hydrogen, halogen,  $C_{1-4}$  alkyl,  $C_{3-7}$  cycloalkyl,  $C_{3-7}$  heterocyclyl,  $C_{2-4}$  alkenyl,  $C_{2-4}$  alkynyl,  $C_{1-4}$  alkoxy, fluoromethyl, difluoromethyl,

trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio, and  $\text{COOR}^c$ ;

Y is selected from bond, carbonyl, oxygen, sulphur,  $-\text{CH}(\text{R}^b)-$ ,  $-\text{NHCO}-$ ,  $-\text{NHSO}_2-$ ,  $-\text{SO}_2\text{NH}-$ ,  $-\text{N}(\text{R}^c)-$  and  $-\text{CR}^6=\text{CR}^7-$ ;

n is an integer selected from 0, 1, 2 and 3;

Z is selected from halogen, amino, hydroxy, mercapto,  $\text{C}_{1-4}$  alkyl,  $\text{C}_{2-4}$  alkenyl,  $\text{C}_{2-4}$  alkynyl,  $\text{C}_{1-4}$  alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy and  $(\text{CH}_2)_p\text{OH}$ , where p is an integer from 1 to 4;

$\text{R}^5$  is selected from  $-\text{CO}_2\text{R}^c$ ,  $-\text{PO}(\text{OR}^c)_2$ ,  $-\text{PO}(\text{OR}^c)\text{NH}_2$ ,  $-\text{SO}_2\text{OR}^c$ ,  $-\text{COCO}_2\text{R}^c$ ,  $\text{CONR}^c\text{OR}^c$ ,  $-\text{SO}_2\text{NHR}^c$ ,  $-\text{NHSO}_2\text{R}^c$ ,  $-\text{CONHSO}_2\text{R}^c$ , and  $-\text{SO}_2\text{NHCOR}^c$ ;

$\text{R}^6$  and  $\text{R}^7$  are independently selected from hydrogen, halogen,  $\text{C}_{1-4}$  alkyl,  $\text{C}_{2-4}$  alkenyl,  $\text{C}_{2-4}$  alkynyl,  $\text{C}_{1-4}$  alkoxy,  $\text{C}_{5-10}$  aryl, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, and  $(\text{CH}_2)_p\text{OH}$ , where p is an integer from 1 to 4;

$\text{R}^a$  is selected from halogen,  $\text{C}_{1-4}$  alkoxy,  $\text{C}_{5-10}$  aryl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio, mercapto, cyano, and nitro;

$\text{R}^{a'}$  is selected from  $\text{R}^a$ , fluoromethyl, difluoromethyl, trifluoromethyl,  $\text{C}_{1-4}$  alkyl, and  $\text{C}_{3-10}$  heterocyclyl- $\text{C}_{2-4}$  alkenyl;

$\text{R}^{a''}$  is selected from:

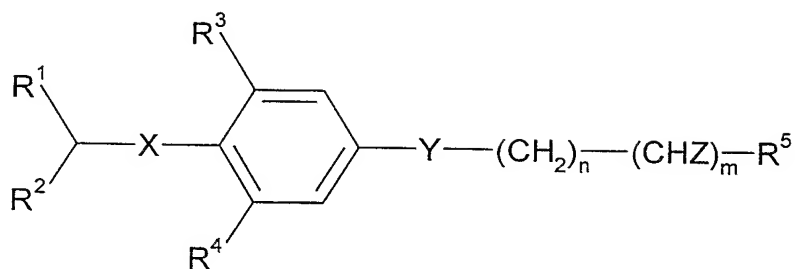
- $\text{R}^{a'}$ ;
- $\text{C}_{2-4}$  alkenyl, optionally substituted with 1, 2 or 3 groups selected from  $\text{C}_{5-10}$  aryl,  $\text{C}(\text{O})\text{R}^c$ ,  $\text{C}_{3-10}$  heterocyclyl, and  $\text{C}_{3-10}$  heterocyclyl substituted with  $\text{C}_{1-4}$  alkyl;

- C<sub>2-8</sub> alkenyloxy;
  - C<sub>3-8</sub> cycloalkyl-C<sub>1-3</sub> alkoxy, C<sub>5-10</sub> aryl-C<sub>1-3</sub> alkoxy, or C<sub>5-10</sub> aryloxy, said C<sub>3-8</sub> cycloalkyl-C<sub>1-3</sub> alkoxy, C<sub>5-10</sub> aryl-C<sub>1-3</sub> alkoxy or C<sub>5-10</sub> aryloxy optionally being substituted with 1, 2 or 3 groups selected from C<sub>1-4</sub> alkyl, halogen, fluoromethyl, difluoromethyl, trifluoromethyl fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, mercapto, hydroxy, cyano, nitro, a group of formula -N(R<sup>c</sup>)<sub>2</sub> in which the two R<sup>c</sup> groups may be the same or different but not both simultaneously hydrogen;
- 10 R<sup>b</sup> is selected from hydrogen, halogen, hydroxyl, mercapto, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub> alkynyl, C<sub>1-4</sub> alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy and (CH<sub>2</sub>)<sub>p</sub>OH, where p is an integer from 1 to 4; and
- R<sup>c</sup> is selected from hydrogen, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl and C<sub>2-4</sub> alkynyl;
- 15 R<sup>c'</sup> is selected from R<sup>c</sup>, C<sub>5-10</sub> aryl or C<sub>5-10</sub> aryl substituted with amino, hydroxyl, halogen or C<sub>1-4</sub> alkyl; and
- m is 1; or
- 20 simultaneously m is 0 or 1 and R<sup>3</sup> is C<sub>3-7</sub> heterocyclyl; or simultaneously Y is bond, m is 0, n is 0 and R<sup>5</sup> is -CO<sub>2</sub>R<sup>c</sup>.

The invention further provides a compound of formula (Ic) or a pharmaceutically acceptable ester, amide, solvate or salt thereof A compound of formula (Ic) or a

25 pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt,





(Ic)

wherein:

R<sup>1</sup> is selected from C<sub>5-10</sub> aryl, C(O)-C<sub>5-10</sub> aryl, C(O)-C<sub>3-8</sub> heterocyclyl or C<sub>5-10</sub>

5 heterocyclyl-C<sub>1-2</sub> alkyl,

- said C(O)-C<sub>5-10</sub> aryl, C(O)-C<sub>3-8</sub> heterocyclyl or C<sub>5-10</sub> heterocyclyl-C<sub>1-2</sub> alkyl optionally being substituted with, where applicable, 1 to 3 groups R<sup>a'</sup> which may be the same or different;

- said C<sub>5-10</sub> aryl being substituted with a group selected from:

10 - C<sub>5-10</sub> aryl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, mercapto, fluoromethyl, difluoromethyl, and C<sub>3-10</sub> heterocyclyl-C<sub>2-4</sub> alkenyl;

- C<sub>2-4</sub> alkenyl, substituted with 1, 2 or 3 groups selected from C<sub>5-10</sub> aryl, C(O)R<sup>c</sup>, C<sub>3-10</sub> heterocyclyl, and C<sub>3-10</sub> heterocyclyl substituted with C<sub>1-4</sub> alkyl;

- C<sub>2-8</sub> alkenyloxy;

15 - C<sub>3-8</sub> cycloalkyl-C<sub>1-3</sub> alkoxy, C<sub>5-10</sub> aryl-C<sub>1-3</sub> alkoxy, or C<sub>5-10</sub> aryloxy, said C<sub>3-8</sub> cycloalkyl-C<sub>1-3</sub> alkoxy, C<sub>5-10</sub> aryl-C<sub>1-3</sub> alkoxy or C<sub>5-10</sub> aryloxy optionally being substituted with 1, 2 or 3 groups selected from C<sub>1-4</sub> alkyl, halogen, fluoromethyl, difluoromethyl, trifluoromethyl fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, mercapto, hydroxy, cyano, nitro, a group of formula  
20 -N(R<sup>c</sup>)<sub>2</sub> in which the two R<sup>c</sup> groups may be the same or different but not both simultaneously hydrogen;

- said aryl optionally also substituted with, where applicable, 1 to 2 groups R<sup>a'</sup> which may be the same or different,

25 R<sup>2</sup> is selected from hydrogen, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub> alkynyl and C<sub>1-4</sub> alkoxy;

X is selected from CH<sub>2</sub>, oxygen, sulfur, sulfoxide, sulfone, selenium, tellurium, disulfide, and a group of formula -N(R<sup>c</sup>)-;

5 R<sup>3</sup> and R<sup>4</sup> are independently selected from hydrogen, halogen, C<sub>1-4</sub> alkyl, C<sub>3-7</sub> cycloalkyl, C<sub>3-7</sub> heterocyclyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub> alkynyl, C<sub>1-4</sub> alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio, and COOR<sup>c</sup>;

10 Y is selected from bond, carbonyl, oxygen, sulphur, -CH(R<sup>b</sup>)-, -NHCO-, -NHSO<sub>2</sub>-, -SO<sub>2</sub>NH-, -N(R<sup>c</sup>)- and -CR<sup>6</sup>=CR<sup>7</sup>-;

n is an integer selected from 0, 1, 2 and 3;

15 Z is selected from halogen, amino, hydroxy, mercapto, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub> alkynyl, C<sub>1-4</sub> alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy and (CH<sub>2</sub>)<sub>p</sub>OH, where p is an integer from 1 to 4;

m is an integer selected from 0 and 1;

20 R<sup>5</sup> is selected from -CO<sub>2</sub>R<sup>c</sup>, -PO(OR<sup>c</sup>)<sub>2</sub>, -PO(OR<sup>c</sup>)NH<sub>2</sub>, -SO<sub>2</sub>OR<sup>c</sup>, -COCO<sub>2</sub>R<sup>c</sup>, CONR<sup>c</sup>OR<sup>c</sup>, -SO<sub>2</sub>NHR<sup>c</sup>, -NHSO<sub>2</sub>R<sup>c</sup>, -CONHSO<sub>2</sub>R<sup>c</sup>, and -SO<sub>2</sub>NHCOR<sup>c</sup>;

25 R<sup>6</sup> and R<sup>7</sup> are independently selected from hydrogen, halogen, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub> alkynyl, C<sub>1-4</sub> alkoxy, C<sub>5-10</sub>aryl, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, and (CH<sub>2</sub>)<sub>p</sub>OH, where p is an integer from 1 to 4;

30 R<sup>a</sup> is selected from halogen, C<sub>1-4</sub> alkoxy, C<sub>5-10</sub> aryl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio, mercapto, cyano, and nitro;

$R^{a'}$  is selected from  $R^a$ , fluoromethyl, difluoromethyl, trifluoromethyl,  $C_{1-4}$  alkyl, and  $C_{3-10}$  heterocyclyl- $C_{2-4}$  alkenyl;

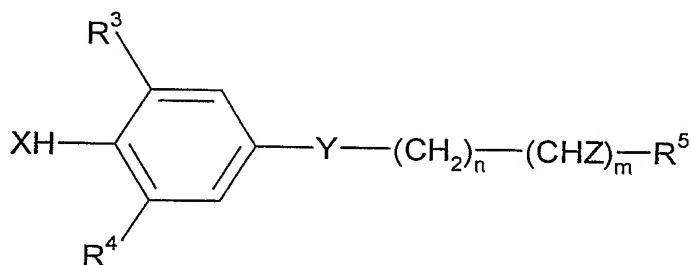
$R^b$  is selected from hydrogen, halogen, hydroxyl, mercapto,  $C_{1-4}$  alkyl,  $C_{2-4}$  alkenyl,  $C_{2-4}$  alkynyl,  $C_{1-4}$  alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy and  $(CH_2)_pOH$ , where  $p$  is an integer from 1 to 4; and

$R^c$  is selected from hydrogen,  $C_{1-4}$  alkyl,  $C_{2-4}$  alkenyl and  $C_{2-4}$  alkynyl; and

$R^{c'}$  is selected from  $R^c$ ,  $C_{5-10}$  aryl or  $C_{5-10}$  aryl substituted with amino, hydroxyl, halogen or  $C_{1-4}$  alkyl.

It will be understood that the preferred features mentioned above in respect of compounds of formula (I) for use in the invention also apply to compounds of formula (Ib) and (Ic).

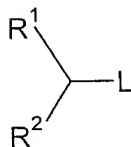
The invention also provides a method for preparing a compound of formula (Ib) as described above or a compound of formula (Ic) as described above comprising a step of adding a compound of formula (II)



(II)

wherein  $X$ ,  $R^3$ ,  $R^4$ ,  $Y$ ,  $n$ ,  $Z$ ,  $m$  and  $R^5$  are as defined above for the compound of formula (Ib) or (Ic), to a compound of formula (III)

31



(III)

wherein R<sup>1</sup> and R<sup>2</sup> are as defined above, as appropriate, for the compound of formula (Ib) or (Ic) and L is a suitable leaving group, in the presence of a suitable base.

Suitable leaving groups L include halogen, OR<sup>c</sup>, -SR<sup>c</sup>, C<sub>1-4</sub>alkyl, C<sub>5-10</sub>aryl or C<sub>5-10</sub>ar-C<sub>1-4</sub>alkyl sulphonate esters, for example, a bromide, a methylsulfonyl or a toluenesulfonyl group. Suitable bases include carbonates, alkylamines and alkali metal hydroxides, for example potassium carbonate, cesium carbonate, potassium hydroxide, sodium hydroxide diisopropylamine and, triethylamine. Trimethylsilanoate may also be used. Other combinations of leaving groups and bases may be employed, as is known by the person skilled in the art. Optionally, one or more coupling reagents may be employed. The reaction mixture is stirred at room temperature, or heated until the starting materials have been consumed. The reaction may be carried out with protecting groups present and those protecting groups may be removed after the reaction. Suitable protecting groups are known to the person skilled in the art (see T. W. Greene, "Protective Groups in Organic Synthesis", 3<sup>rd</sup> Edition, New York, 1999).

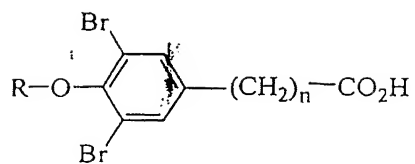
The invention will now be illustrated by the following Examples, which do not in any way limit the scope of the invention.

### Examples

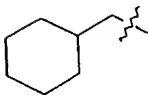
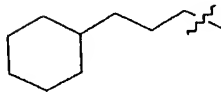
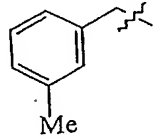
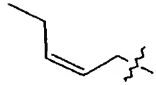
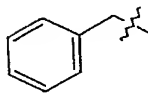
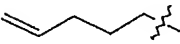

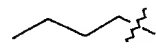
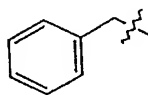
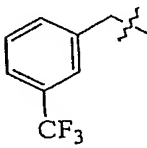
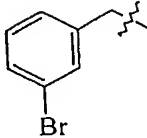
The following compounds illustrate compounds of the invention or, where appropriate, compounds for use in the invention.

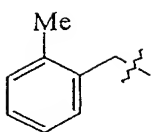
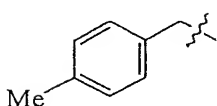
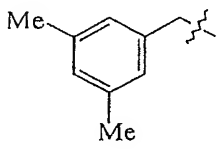
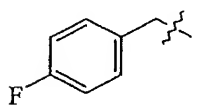
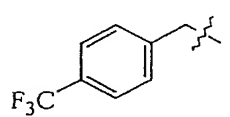
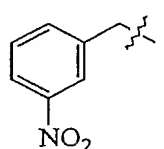
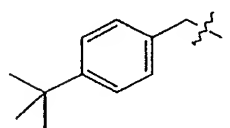
Example compounds 1 to 30 are shown in Table 1.

Table 1:



Example	R	n	Method	Yield <sup>1</sup>	MS <sup>2</sup>
1		1	A	89	365.2
2		1	A	32	365.2
3		1	A	81	379
4		1	A	90	379
5		1	A	71	393.1
6		1	A	79	393.1
7		1	A	74	405.1
8		2	A	68	379
9		2	A	88	293.1
10		2	A	92	407.2
11		2	A	90	393.1
12		2	A	70 <sup>3</sup>	407.2

13		2	A	63	419.2
14		2	B	30	-
15		2	B	66	428.1
16		2	B	64	391
17		2	B	82	412.9
18		2	B	77	390.4
19		2	B	50	-
20		1	A	96	365.2
21		1	C	37	400.1
22		2	C	84	482.1
23		2	C	67	493

24		2	C	97	428.1
25		2	C	95	428.1
26		2	C	75	442.1
27		2	C <sup>4</sup>	5	432.1
28		2	C <sup>4</sup>	42	482.1
29		2	C	65	459.1
30		2	C <sup>4</sup>	4	470.2

<sup>1)</sup> Yields in %.

<sup>2)</sup> MS result obtained on a Perkin-Elmer API 150Ex spectrometer, using electrospray negative ion mode.

<sup>3)</sup> This substance fell as an oil during final work-up. In order to get crystals the methanol was removed in vacuo and the remaining water phase, extracted with ethyl acetate. After drying over magnesium sulphate and removal of the organic phase, a crystal mass was obtained.

<sup>4)</sup> In Examples 27, 28 and 30, the final compound was first separated in 2 g silica pre-packed in 3 mL SPE cartridges employing the same gradient of solvents described in Procedure C and then further purified by semi-preparative-HPLC (Zorbax CombiHT (SB-C8 50x21.2 mm, 5μ) Mobil Phase: Solvent A. Water with 0.5% formic acid; Solvent B: acetonitrile. Gradient: 2 min 80% of A then over 8 min to 5% of A).

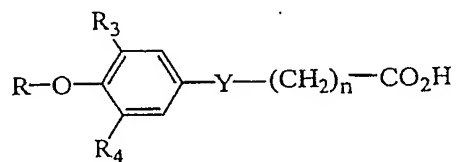
Example compounds 31 to 35 are the following:

- 31: *N*-[3,5-Dibromo-4-(3-bromobenzyloxy)benzoyl]benzenesulphonamide  
5 32: *N*-[3,5-Dibromo-4-(3-bromobenzyloxy)benzoyl]-3-nitrobenzenesulphonamide  
33: *N*-[3,5-Dibromo-4-(3-bromobenzyloxy)benzoyl]-4-nitrobenzenesulphonamide  
34: 4-Amino-*N*-[3,5-dibromo-4-(3-bromobenzyloxy)benzoyl]benzenesulphonamide  
35: *N*-[3,5-Dibromo-4-(3-bromobenzyloxy)benzoyl]methanesulphonamide

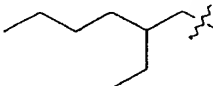

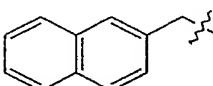
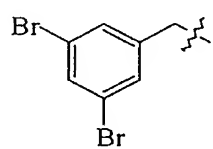
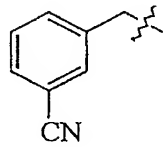
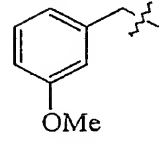
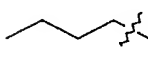
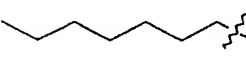
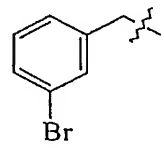
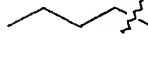
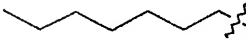
10

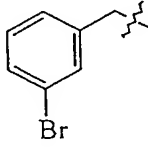
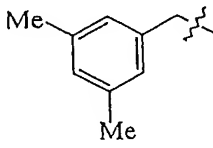
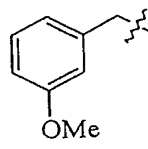
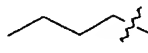
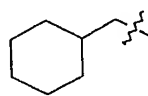
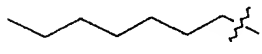
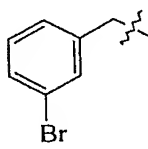
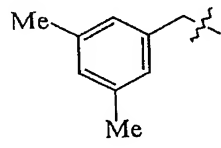
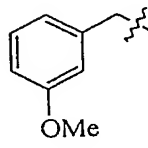
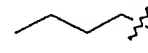
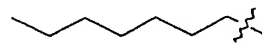
Example compounds 36 to 100 are shown in Table 2:

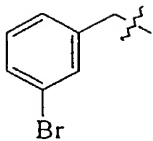
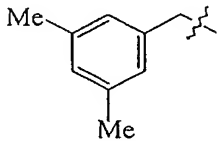
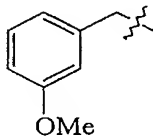
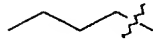
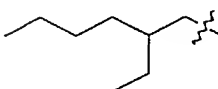
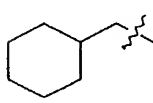

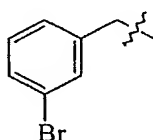
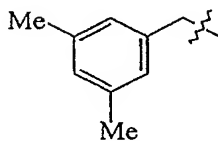
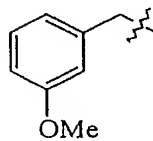
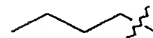
**Table 2:**

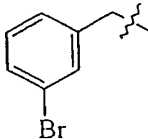
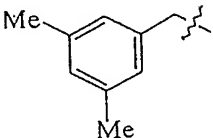
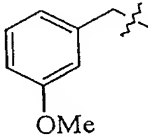
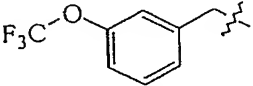
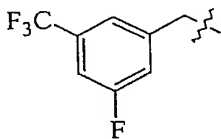
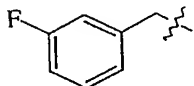
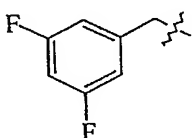
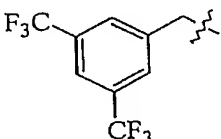
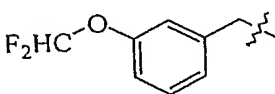


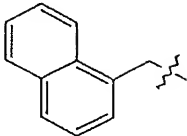
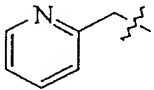
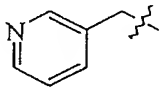
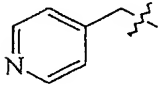
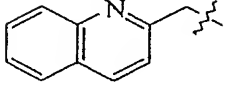
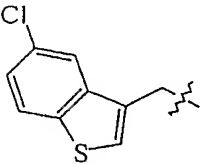
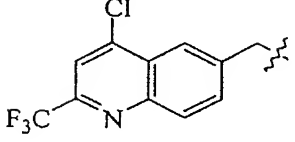
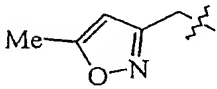
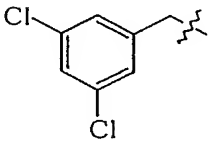
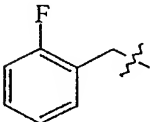


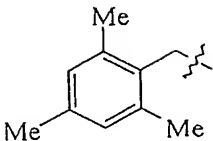
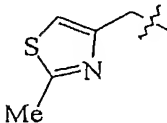
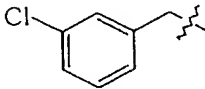
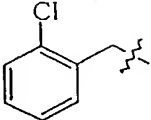
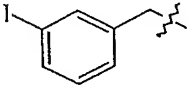
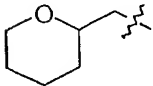
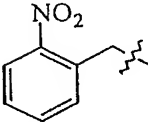
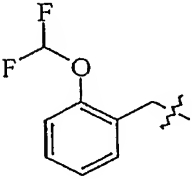
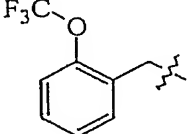
Example	R	R <sub>3</sub> ,R <sub>4</sub>	Y	n	Solvent	Equiv. halide	Hydrol. Method	Yield (%)	MS <sup>1</sup>
36		Br	CH <sub>2</sub>	0	acetone	4	D1	27	421.0
37		Br	CH <sub>2</sub>	0	acetone	4	D4	75	363.1
38		Br	CH <sub>2</sub>	1	acetone	4	D2	34	463.0
39		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D3	38	570.7
40		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D3	51	437.8
41		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D3	91	443.2
42		Cl	CHOH	0	CH <sub>3</sub> CN	2	D4	58	290.8
43		Cl	CHOH	0	CH <sub>3</sub> CN	2	D4	52	333.1
44		Cl	CHOH	0	CH <sub>3</sub> CN	2	D4	64	404.8
45		Cl	C=O	0	CH <sub>3</sub> CN	2	D4	48	289.0
46		Cl	C=O	0	CH <sub>3</sub> CN	2	D4	12	330.7

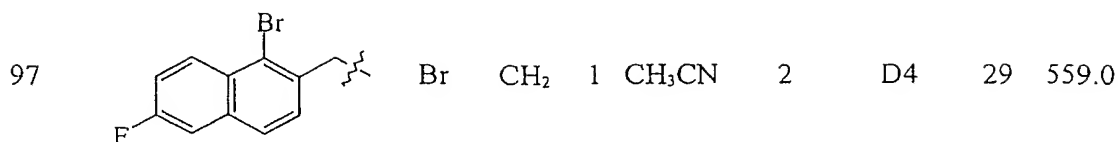
47		Cl	C=O	0	CH <sub>3</sub> CN	2	D4	64	402.7
48		Cl	C=O	0	CH <sub>3</sub> CN	2	D4	7	351.1
49		Cl	C=O	0	CH <sub>3</sub> CN	2	D4	63	352.9
50		Me	CH <sub>2</sub>	0	CH <sub>3</sub> CN	2	D4	61	235.0
51		Me	CH <sub>2</sub>	0	CH <sub>3</sub> CN	2	D4	46	275.2
52		Me	CH <sub>2</sub>	0	CH <sub>3</sub> CN	2	D4	61	277.0
53		Me	CH <sub>2</sub>	0	CH <sub>3</sub> CN	2	D4	78	349.0
54		Me	CH <sub>2</sub>	0	CH <sub>3</sub> CN	2	D4	76	297.1
55		Me	CH <sub>2</sub>	0	CH <sub>3</sub> CN	2	D4	85	299.2
56		Me	C=O	0	CH <sub>3</sub> CN	2	D4	43	248.8
57		Me	C=O	0	CH <sub>3</sub> CN	2	D4	82	290.8

58		Me	C=O	0	CH <sub>3</sub> CN	2	D4	93	361.0
59		Me	C=O	0	CH <sub>3</sub> CN	2	D4	85	310.9
60		Me	C=O	0	CH <sub>3</sub> CN	2	D4	86	313.0
61		<i>i</i> -Pr	C=O	0	CH <sub>3</sub> CN	2	D4	55	305.2
62		<i>i</i> -Pr	C=O	0	acetone	4	D1	26	361.3
63		<i>i</i> -Pr	C=O	0	CH <sub>3</sub> CN	2	D4	53	344.8
64		<i>i</i> -Pr	C=O	0	CH <sub>3</sub> CN	2	D4	51	346.9
65		<i>i</i> -Pr	C=O	0	CH <sub>3</sub> CN	2	D4	61	417.1
66		<i>i</i> -Pr	C=O	0	CH <sub>3</sub> CN	2	D4	72	367.0
67		<i>i</i> -Pr	C=O	0	CH <sub>3</sub> CN	2	D4	72	368.8
68		<i>i</i> -Pr	CH <sub>2</sub>	0	CH <sub>3</sub> CN	2	D4	41	291.1

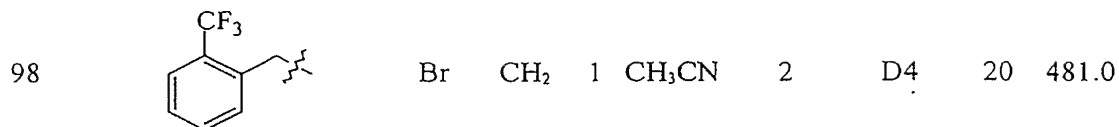
69		<i>i</i> -Pr	CH <sub>2</sub>	0	CH <sub>3</sub> CN	2	D4	25	405.1
70		<i>i</i> -Pr	CH <sub>2</sub>	0	CH <sub>3</sub> CN	2	D4	23	353.2
71		<i>i</i> -Pr	CH <sub>2</sub>	0	CH <sub>3</sub> CN	2	D4	25	355.0
72		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	100	497.2
73		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	86	499
74		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	100	430.9
75		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	100	448.9
76		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	61	549.1
77		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	91	478.9

78		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	100	463.0
79		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	49	413.8
80		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	32	413.8
81		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	58	413.8
82		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	93	463.9
83		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	9	502.9
84		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	63	565.9
85		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	88	418.0
86		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	46	480.7
87		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	38	430.9

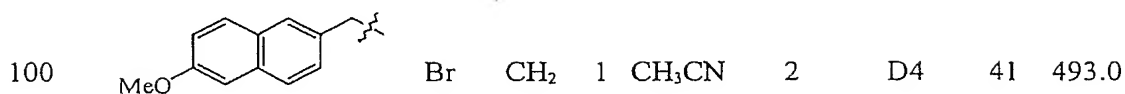
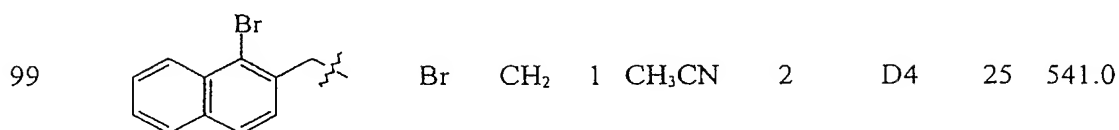
88		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	76	454.9
89		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	46	433.9
90		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	94	446.8
91		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	97	446.8
92		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	30	538.9
93		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	76	421.0
94		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	36	457.9
95		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	17	478.9
96		Br	CH <sub>2</sub>	1	CH <sub>3</sub> CN	2	D4	28	497.2



5



10



15

<sup>1)</sup> MS result obtained on a Perkin-Elmer API 150Ex spectrometer, using electrospray negative ion mode.

20

Example compounds 101 to 104 and 106 to 110 are the following:

101: 3-[3,5-dibromo-4-(3-ethoxybenzyloxy)phenyl]propionic acid

102: 3-[3,5-dibromo-4-(3-propyloxybenzyloxy)phenyl]propionic acid

25 103: 3-[3,5-dibromo-4-(3-butyloxybenzyloxy)phenyl]propionic acid

104: 3-[3,5-dibromo-4-(3-aminobenzyloxy)phenyl]propionic acid

106: 3-[3,5-dibromo-4-(3-diethylaminebenzyloxy)phenyl]propionic acid

107: N-[3,5-Dibromo-4-(3-bromobenzyloxy)phenyl]oxamic acid

108: N-[3,5-Dibromo-4-(2-methylnaphthyloxy)phenyl]oxamic acid

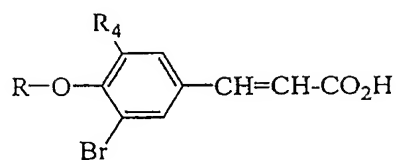
30 109: 3-[3-bromo-5-methoxy-4-(3-bromobenzyloxy)phenyl]propionic acid

110: 3-[3-bromo-5-methoxy-4-(2-methylnaphthyloxy)phenyl]propionic acid

Example compounds 111 to 121 are shown in Table 3:

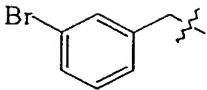
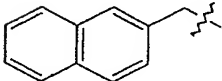
**Table 3:**

5



Example	R	R <sub>4</sub>	Yield (%)	MS <sup>1</sup>
111		Br	35	478.9
112		Br	34	424.9
113		Br	58	495.1
114		Br	28	412.0
115		Br	10	461.8
116		Br	53	497.2
117		Br	62	415.9
118		Br	47	488.8
119		Br	10	460.9



120		OMe	19	442.1
121		OMe	6	413.3

---

The synthesis of the Example compounds 1 to 104 and 106 to 121 is described in detail at pages 34 to 53 of WO01/36365 where the same compound numbering is used. The synthesis of example compounds 122 to 126 is described immediately below.

**Abbreviations:**

BOC: *tert*-butoxy

15 SPE: Solid Phase Extraction

SCX: benzenesulphonic acid silane, strong cation exchanger

**Example 122 3-{3,5-dibromo-4-[2-(1*H*-indol-3-yl)ethoxy]phenyl}propanoic acid**

*N*-BOC-3-(2-bromoethyl)indole was prepared from 2-(2-bromoethyl)indole and di-*tert* butyldicarbonate using standard conditions.

To a solution of 3-(3,5-dibromo-4-hydroxy-phenyl)propionic acid methyl ester (12 mg, 0.035 mmol) in dry acetonitrile (0.25 mL) was added potassium carbonate (15 mg, 0.11 mmol) and the resulting mixture was stirred at room temperature. After 15 minutes a solution of *N*-BOC-3-(2-bromoethyl)indole (22.7 mg, 0.07 mmol) in 0.25 mL dry acetonitrile was added. The mixture was heated at 80 °C over night. After cooling down to room temperature, the mixture was filtered through a silica SPE column (500 mg/3 mL), eluting with *n*-heptane/ethyl acetate 3:1 (3 mL). After concentration *in vacuo* the residue was dissolved in tetrahydrofuran (0.25 mL) and lithium hydroxide (1 N in water, 0.25 mL) was added. The mixture was stirred over night and then neutralised on an SCX SPE column (500 mg/3 mL), using methanol as eluent. After evaporation of the solvents,

the residue was dissolved in trifluoroacetic acid (10%) in dichloromethane. After four hours at room temperature, the mixture was concentrated and the residue was dissolved in methanol (0.25 mL) after which pH was adjusted to 5 with triethylamine in methanol. The mixture was again concentrated *in vacuo* and the product was redissolved in a minimum amount of methanol. It was then purified on an SPE-C18 column (500 mg/3 mL), using acetonitrile/H<sub>2</sub>O 1:1 as eluent to give 12.9 mg 3-{3,5-dibromo-4-[2-(1*H*-indol-3-yl)ethoxy]phenyl}propanoic acid (70%) as the triethylamine salt. MS: *m/z* 466.0 (*M*<sup>+</sup>-1)

10 **Example 123 3-[4-(biphenyl-2-ylmethoxy)-3,5-dibromophenyl]propanoic acid**

To a solution of 3-(3,5-dibromo-4-hydroxy-phenyl)propionic acid methyl ester (12 mg, 0.035 mmol) in dry acetonitrile (0.25 mL) was added potassium carbonate (15 mg, 0.11 mmol) and the resulting mixture was stirred at room temperature. After 15 minutes a solution of 2-phenylbenzyl bromide (12.8 mg, 0.07 mmol) in 0.25 mL dry acetonitrile was added. The mixture was heated at 80 °C over night. After cooling down to room temperature, the mixture was filtered through a silica SPE column (500 mg/3 mL), eluting with *n*-heptane/ethyl acetate 3:1 (3 mL). After concentration *in vacuo* the residue was dissolved in tetrahydrofuran (0.25 mL) and lithium hydroxide (1 N in water, 0.25 mL) was added. The mixture was stirred over night and then neutralised on an SCX SPE column (500 mg/3 mL), using methanol as eluent. After evaporation of the solvents, the residue was purified on a silica SPE column (500 mg/3 mL) with dichloromethane/methanol 9:1 as eluent giving 12.5 mg 3-[4-biphenyl-2-yl-methoxy)-3,5-dibromo-phenyl]-propionic acid (73%). MS: *m/z* 488.8 (*M*<sup>+</sup>-1)

25 **Example 124 3-{3,5-dibromo-4-[(3-bromobenzyl)oxy]phenyl}-2-hydroxypropanoic acid**

To a solution of 2-hydroxy-3-(4-hydroxy-phenyl)-propionic acid (4g, 21.95 mmol) in methanol (50 mL) was added HCl (1.5 mL). The reaction mixture was stirred at room temperature over night. The solvent was evaporated and diluted with ethyl acetate (160 mL) and which was washed with aqueous solution of sodium bicarbonate (2 x 20 mL). The organic phase was dried over MgSO<sub>4</sub> and solvent was removed. The crude reaction

mixture was filtered through silica gel to give compound 2-hydroxy-3-(4-hydroxy-phenyl)-propionic acid methyl ester 3.45 g (80%).

To a mixture of 2-hydroxy-3-(4-hydroxy-phenyl)-propionic acid methyl ester (3.45 g, 17.58 mmol) in acetic acid (85 mL) and 4-5 drops of water was added sodium acetate (7.18 g, 52.8 mmol), followed by drop-wise addition of bromine (8.43 g, 52.8 mmol) in acetic acid (10 mL). The reaction mixture was stirred at room temperature for over night under dark. The reaction mixture was treated with aqueous solution of  $\text{Na}_2\text{S}_2\text{O}_3$  and concentrated. The mixture was dissolved in ethyl acetate and washed with  $\text{H}_2\text{O}$ . The solvent was removed and the crude reaction mixture was purified on (silica gel, *n*-heptane/ethyl acetate, gradient elution from 100 to 40 % *n*-heptane). This gave 3-(3,5-dibromo-4-hydroxy-phenyl)-2-hydroxy-propionic acid methyl ester (5.2 g) in 64%.

A mixture of the 3-(3,5-dibromo-4-hydroxy-phenyl)-2-hydroxy-propionic acid methyl ester (4.2 g, 11.86 mmol) and potassium carbonate (1.88 mg, 13.02 mmol) in acetonitrile (220 mL) was stirred at room temperature. After 10 minutes the *m*-bromo benzyl bromide (3.26g, 13.04 mmol) was added. The reaction mixture was heated at reflux over night, cooled to room temperature and concentrated *in vacuo*. Diethyl ether was added to the residue, the solution filtered on silica and the resulting filtrate concentrated. The residue was dissolved in methanol 200 mL. An aqueous solution of sodium hydroxide (50 mL, 1 N) was added dropwise and the reaction mixture was stirred at room temperature for 16 hours, and acidified with hydrochloric acid (1N). The precipitate formed was collected and dried. The crude reaction mixture was purified by HPLC (C8 column, 35 % acetonitrile in aqueous ammonium acetate buffer) gave 3-[3,5-dibromo-4-(3-bromobenzyloxy)-phenyl]-2-hydroxy-propionic acid 2.96 g (49%). MS:  $m/z$  507 ( $\text{M}^+-1$ )

**Example 125 2-chloro-3-{3,5-dibromo-4-[(3-bromobenzyl)oxy]phenyl}propanoic acid**

To a suspension of 4-amino-phenol (12g, 0.11 mol) and concentrated HCl (25 mL) in acetone (175 mL), sodium nitrite (8.28 g, 0.12 mol) in  $\text{H}_2\text{O}$  (25 mL) was added at  $-40^\circ\text{C}$ . The dark mixture was stirred for 45 minutes at  $-10^\circ\text{C}$  and the temperature was raised to

+ 10 °C. Methyl acrylate (50 mL, 0.56 mol) was added in the reaction mixture and heated to 30 °C and then copper (I) iodide (0.5 g, 2.6 mmol) was added portion wise. The temperature was maintained between 30 °C to 32 °C during the addition copper (I) iodide. The dark suspension was stirred at 31 °C for 30 minutes. The reaction mixture was stirred  
5 at room temperature over night. The solvent was removed at reduced pressure and the crude reaction mixture was dissolved in dichloro methane (200 mL). The organic layer was washed with water (250 mL). The aqueous layer was washed with dichloro methane (2 x 200 mL). The combined organic layer was washed with water (3 x 200 mL) and brine (250 mL). The organic layer was dried over MgSO<sub>4</sub> and filtered and the filtrate was  
10 evaporated at reduced pressure. The crude reaction mixture was purified by HPLC to give desired compound 2-chloro-3-(4-hydroxy-phenyl)-propionic acid methyl ester.

To a mixture of 2-chloro-3-(4-hydroxy-phenyl)-propionic acid methyl ester (100 mg, 0.47 mmol), acetic acid (4.5 mL) and 4-5 drops of water was added sodium acetate (127  
15 mg, 0.932 mmol), followed by drop-wise addition of bromine (149 mg, 0.932 mmol) in acetic acid (1 mL). The reaction mixture was stirred at room temperature for 2 hours. The reaction mixture was treated with aqueous solution of Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> and concentrated. The mixture was dissolved in ethyl acetate (10 mL) and washed with H<sub>2</sub>O (2 x 10 mL). The solvent was removed to give 2-chloro-3-(3,5-dibromo-4-hydroxy-phenyl)-propionic acid  
20 methyl ester 160 mg (92%) and which was used directly in the next step without any further purification.

A mixture of the 2-chloro-3-(3,5-dibromo-4-hydroxy-phenyl)-propionic acid methyl ester (130 mg, 0.35 mmol) and potassium carbonate (48 mg, 0.35 mmol) in acetone (15 mL)  
25 was stirred at room temperature. After 10 minutes of stirring the m-bromo benzyl bromide (87 mg, 0.35 mmol) was added. The reaction mixture was heated at reflux over night, cooled to room temperature and concentrated *in vacuo*. Diethyl ether was added to the residue, the solution filtered through silica gel and the resulting filtrate concentrated. The residue was dissolved in THF (1 mL) and methanol 2 mL. An aqueous solution of  
30 sodium hydroxide (0.45 mL, 1 N) was added dropwise and the reaction mixture was stirred at room temperature for 16 hours, and acidified with hydrochloric acid (1N). The

precipitate formed was collected and dried. The crude reaction mixture was purified by HPLC (40-70% acetonitrile in H<sub>2</sub>O) gave desired 2-chloro-3-[3,5-dibromo-4-(3-bromobenzyloxy)-phenyl]-propionic acid 94 mg (51%). MS: m/z 526.0 (M<sup>+</sup>-1)

5    **Example 126: 3-[3,5-dibromo-4-({2-[(E)-2-pyridin-4-ylvinyl]benzyl}oxy)phenyl]propanoic acid**

3-[3, 5-Dibromo-4-(2-iodo-benzyloxy)-phenyl] propionic acid methyl ester was prepared from methyl 3-(3,5-dibromo-4-hydroxyphenyl)propionate and 2-iodobenzyl bromide in a procedure analogous to the preparation of Examples 122 and 123.

10

To a solution of 3-[3,5-dibromo-4-(2-iodo-benzyloxy)-phenyl] propionic acid methyl ester (25 mg, 0.045 mmol) in dry *N,N*-dimethylformamide (0.25 mL) was added a solution of 4-vinylpyridine (23.5 mg, 0.23 mmol) in dry *N,N*-dimethylformamide (0.25 mL) followed by triethylamine (0.031 mL, 0.23 mmol), palladium(II) acetate (1.0 mg, 0.0045 mmol) and tetrabutylammonium chloride (13 mg, 0.045 mmol). The resulting mixture was stirred at 100 °C over night and was subsequently filtered through a celite plug. After evaporation of the solvents *in vacuo*, the residue was purified on a silica SPE column (500 mg/3 mL) eluting with a gradient mixture starting with *n*-heptane/ethyl acetate 99:1. The product containing fractions were collected and concentrated and the residue was subsequently dissolved in tetrahydrofuran (0.25 mL). LiOH<sub>(aq)</sub> (1M, 0.25 mL) was added and the resulting mixture was stirred at room temperature over night. The mixture was then neutralised on an SCX SPE column (500 mg/3 mL) using triethylamine (10% in methanol) as eluent. After evaporation of the solvents the crude product was purified on a silica SPE column (1 g/3 mL) with a gradient starting with dichloromethane/methanol 99:1. The product containing fractions were collected and concentrated *in vacuo* yielding 2.1 mg 3-[3,5-dibromo-4-(2-((E)-2-pyridin-4-yl-vinyl)-benzyloxy)-phenyl]] propionic acid (9 %).

15

20

25

MS: m/z 516.2 (M<sup>+</sup>-1)

30    **Further examples**

Example compounds 127 to 142 were prepared by methods analogous to those described above.

- 127: 3-(3,5-dibromo-4-{[3-(4-fluorophenoxy)benzyl]oxy}phenyl)propanoic acid  
128: 3-(3,5-dibromo-4-{[3-(2-phenyl(E)vinyl)benzyl]oxy}phenyl)propanoic acid  
5 129: 3-[3,5-dibromo-4-({3-[(E)-2-(4-methyl-1,3-thiazol-5-yl)vinyl]benzyl}oxy)phenyl]  
propanoic acid  
130: 3-(4-{[3-(3-methylbenzyloxy)benzyl]oxy}-3,5-dibromophenyl)propanoic acid  
131: 3-[3,5-dibromo-4-(2-naphthylmethoxy)phenyl]-2-hydroxypropanoic acid  
132: 3,5-dibromo-4-[(3-bromobenzyl)oxy]-N-(phenylsulfonyl)benzamide  
10 133: 3-(3,5-dibromo-4-{[3-(pent-4-en-1-yloxy)benzyl]oxy}phenyl)propanoic acid  
134: {3,5-dibromo-4-[2-(5,5,8,8-tetramethyl-5,6,7,8-tetrahydronaphthalen-2-yl)-2-  
oxoethoxy]phenyl}propanoic acid  
135: 3,5-dibromo-4-[(3-bromobenzyl)oxy]benzoic acid  
136: 3-[3,5-dibromo-4-({3-[(E)-2-pyridin-4-ylvinyl]benzyl}oxy)phenyl]propanoic acid  
15 137: 3-{3,5-dibromo-4-[2-(3-methyl-1-benzothien-2-yl)-2-oxoethoxy]phenyl}propanoic  
acid  
138: 3-{3-bromo-4-[(3-bromobenzyl)oxy]-5-piperidin-1-ylphenyl}propanoic acid  
139: 3-(3,5-dibromo-4-{[3-(cyclopropylmethoxy)benzyl]oxy}phenyl)propanoic acid  
140: 3-[3,5-dibromo-4-({2-[(1E)-2-methyl-3-oxobut-1-en-1-yl]benzyl}oxy)phenyl]  
20 propanoic acid  
141: 3-[3,5-dibromo-4-({3-[(1E)-2-methyl-3-oxobut-1-en-1-yl]benzyloxy)phenyl]  
propanoic acid  
142: 3,5-dibromo-O-(3-bromobenzyl)tyrosine

25 Some specific examples of those are now described:

**Example 127:** 3-(3,5-dibromo-4-{[3-(4-fluorophenoxy)benzyl]oxy}phenyl)propanoic acid

**Example 137:** 3-{3,5-dibromo-4-[2-(3-methyl-1-benzothien-2-yl)-2-  
30 oxoethoxy]phenyl}propanoic acid, and

**Example 134: {3,5-dibromo-4-[2-(5,5,8,8-tetramethyl-5,6,7,8-tetrahydronaphthalen-2-yl)-2-oxoethoxy]phenyl}propanoic acid**

To a solution of methyl 3-(3,5-dibromo-4-hydroxyphenyl)propionate (12 mg, 0.035 mmol) in dry acetonitrile (0.25 mL) was added potassium carbonate (15 mg, 0.11 mmol) and the resulting mixture was stirred at room temperature. After 15 minutes a solution of the appropriate halide (0.07 mmol) in 0.25 mL dry acetonitrile was added followed by sodium iodide (1 mg, 0.007 mmol) when the halide is a chloride. The mixture was heated at 80 °C over night. After cooling down to room temperature, the mixture was filtered through a silica SPE column (500 mg/3 mL), eluting with *n*-heptane/ethyl acetate 3:1 (3 mL). After concentration *in vacuo* the residue was dissolved in tetrahydrofuran (0.25 mL) and lithium hydroxide (1 N in water, 0.25 mL) was added. The mixture was stirred over night and then neutralised on an SCX SPE column (500 mg/3 mL), using methanol as eluent. After evaporation of the solvents, the residue was purified on a silica SPE column (500 mg/3 mL) with dichloromethane/methanol as eluent giving the final product.

**Yields**

Example 127: KB003818: 12.4 mg (67%); MS:  $m/z$  523.0 ( $M^+-1$ )

Example 137: 6.7 mg (36%); MS:  $m/z$  511.0 ( $M^+-1$ )

Example 134: 20.4 mg (100%); MS:  $m/z$  551.2 ( $M^+-1$ )

**Example 139: 3-(3,5-dibromo-4-{[3-(cyclopropylmethoxy)benzyl]oxy}phenyl)propanoic acid and****Example 133: 3-(3,5-dibromo-4-{[3-(pent-4-en-1-yloxy)benzyl]oxy}phenyl)propanoic acid**

To a solution of methyl 3-[3,5-dibromo-4-(3-hydroxyphenyl)]propionate (15 mg, 0.032 mmol) in dry acetonitrile (0.25 mL) was added potassium carbonate (18 mg, 0.13 mmol) and the resulting mixture was stirred at room temperature. After 15 minutes a solution of the appropriate bromide (0.13 mmol) in 0.25 mL dry acetonitrile was added. The mixture was heated at 80 °C over night. After cooling down to room temperature, the mixture was filtered through a silica SPE column (400 mg/2 mL), eluting with *n*-heptane/ethyl acetate 3:1 (3 mL). After concentration *in vacuo* the residue was dissolved in tetrahydrofuran

(0.25 mL) and lithium hydroxide (1 N in water, 0.25 mL) was added. The mixture was stirred over night and then neutralised on an SCX SPE column (400 mg/2 mL), using methanol as eluent. After evaporation of the solvents, the residue was purified on a silica SPE column (400 mg/2 mL) with dichloromethane/methanol 9:1 as eluent giving the final product.

#### *Yields*

Example 139: 9.1 mg (53%); MS: m/z 541.0 ( $M^+ - 1$ )

Example 133: 9.1 mg (52%); MS: m/z 497.2 ( $M^+ - 1$ )

10

**Example 128: 3-(3,5-dibromo-4-([3-(2-phenyl(E)vinyl)benzyl]oxy)phenyl)propanoic acid**

**Example 141: 3-[3,5-dibromo-4-([3-[(1E)-2-methyl-3-oxobut-1-en-1-yl]benzyloxy)phenyl] propanoic acid**

15

**Example 136: 3-[3,5-dibromo-4-([3-[(E)-2-pyridin-4-ylvinyl]benzyl]oxy)phenyl] propanoic acid and**

**Example 129: 3-[3,5-dibromo-4-([3-[(E)-2-(4-methyl-1,3-thiazol-5-yl)vinyl]benzyl]oxy) phenyl] propanoic acid**

Methyl 3-[3,5-dibromo-4-(3-iodophenyl)]propionate and was prepared from methyl 3-(3,5-dibromo-4-hydroxyphenyl)propionate and 3-iodobenzyl bromide in a procedure analogous to the preparation of Example 130, 142 and 138 as described above.

20

To a solution of methyl 3-[3,5-dibromo-4-(3-iodophenyl)]propionate (25 mg, 0.045 mmol) in dry *N,N*-dimethylformamide (0.25 mL) was added a solution of the appropriate alkene (0.23 mmol) in dry *N,N*-dimethylformamide (0.25 mL) followed by triethylamine (0.031 mL, 0.23 mmol), palladium(II)acetate (1.0 mg, 0.0045 mmol) and tetrabutylammonium chloride (13 mg, 0.045 mmol). The resulting mixture was stirred at 100 °C over night and was subsequently filtered through a celite plug. After evaporation of the solvents *in vacuo*, the residue was purified on a silica SPE column (500 mg/3 mL) eluting with a gradient mixture starting with *n*-heptane/ethyl acetate 99:1. The product containing fractions were collected and concentrated and the residue was subsequently

30



dissolved in tetrahydrofuran (0.25 mL). LiOH<sub>(aq)</sub> (1M, 0.25 mL) was added and the resulting mixture was stirred at room temperature over night. The mixture was then neutralised on an SCX SPE column (500 mg/3 mL) using methanol or triethylamine (10% in methanol) as eluent. After evaporation of the solvents the crude product was  
5 purified on a silica SPE column (1 g/3 mL) with a gradient starting with dichloromethane/methanol 99:1. The product containing fractions were collected and concentrated *in vacuo* to give the final product.

#### *Yields*

10 Example 128: 0.76 mg (3.3 %); MS: m/z 514.8 (M<sup>+</sup>-1)

Example 141: 0.5 mg (2.2 %); MS: m/z 495.2 (M<sup>+</sup>-1)

Example 136: 0.5 mg (2.1 %); MS: m/z 516.2 (M<sup>+</sup>-1)

Example 129: 1.3 mg (5.4 %); MS: m/z 536.0 (M<sup>+</sup>-1)

15 **Example 140: 3-[3,5-dibromo-4-({2-[(1*E*)-2-methyl-3-oxobut-1-en-1-yl]benzyl}oxy)phenyl]propanoic acid**

The procedure was carried out as described immediately above, but starting from methyl 3-[3,5-dibromo-4-(2-iodophenyl)]propionate (prepared in a procedure analogous to the preparation of 3-[3,5-dibromo-4-(3-iodophenyl)]propionate) and 3-methyl-3-butene-2-on  
20 (19.3 mg).

*Yield:* 1.1 mg (5 %). MS: m/z 495.2 (M<sup>+</sup>-1)

#### **Assay Example 1 AR Competition Binding Assay**

Recombinant human androgen receptor (hAR) was extracted from Sf9 insect cells with  
25 buffer containing 1 mM EDTA, 20 mM K<sub>2</sub>HPO<sub>4</sub>, 8.7% glycerol, 20 mM Na<sub>2</sub>MoO<sub>4</sub> and 12 mM MTG at 5\*10<sup>7</sup> cells/ml. The cell debris was removed by centrifugation and the supernatant aliquoted and stored at -70°C.

An aliquot of AR extract was thawed on ice prior to use and diluted to approximately 0.2  
30 nM (1 to 30 dilution) in buffer (100 mM K<sub>n</sub>H<sub>m</sub>PO<sub>4</sub> pH 7.0, 1 mM EDTA, 8.7% glycerol, 20 mM Na<sub>2</sub>MoO<sub>4</sub> and 1 mM DTT). The test ligands were diluted in DMSO as a dilution

series of 10 concentrations in duplicate, with 1:5 dilution between each concentration. Tritiated mibolerone ( $^3\text{H}$ -Mib) was used as tracer compound and diluted to 1.6 nM in 1 mM EDTA, 20 mM  $\text{Na}_2\text{MoO}_4$ , 8.7% glycerol and 1 mM DTT. To a 96-well polypropylene-plate 110  $\mu\text{l}$ /well of 1.6 nM  $^3\text{H}$ -Mib, 10  $\mu\text{l}$ /well test substance and 110  $\mu\text{l}$ /well diluted AR was added. The plates were covered and incubated at  $+4^\circ\text{C}$  over night. The plates were harvested on filters to separate bound ligand from unbound ligand with a Tomtec Harvester. A prewet buffer containing 20 mM  $\text{K}_n(\text{PO}_4)$  pH 7.6, 1 mM EDTA, v/v 0.5% polyethyleneimin was used to equilibrate the filter before filtering the samples and washing the filters with 20 mM  $\text{K}_n(\text{PO}_4)$  pH 7.6, 1 mM EDTA 8 times. The filters were allowed to dry for 1 hour at  $+65^\circ\text{C}$ . A scintillating wax was melted upon the filter and the radioactivity retained on the filter was measured in a Wallac Microbeta scintillation counter.

The affinity to AR was evaluated by a non-linear four-parameter logistic model:  $b = (b_{\text{max}} - b_{\text{min}})/(1 + (\text{IC}_{50}/I)^S) + b_{\text{min}}$ , where  $b_{\text{max}}$  = total concentration of binding sites,  $b_{\text{min}}$  = non-specific binding,  $I$  = added concentration of binding inhibitor,  $\text{IC}_{50}$  = concentration of binding inhibitor at half-maximal binding and  $S$  = slope factor. Table: Antagonist and partial antagonist and binding activity of androgen receptor modulator compounds.

### Assay Example 2 AR Transactivation Assay

The agonist and antagonist properties of compounds were determined using a cell-based system expressing stably integrated androgen receptor and an androgen responsive reporter gene. CV-1 cells (kidney fibroblasts) stably expressing CMV-hAR and alkaline phosphatase (ALP) driven by an MMTV promoter containing an androgen response element were cultured in Dulbecco's Modified Eagle Medium (DMEM), low glucose supplemented with 10% fetal bovin serum, 1% L-glutamine, and 0.7% Hygromycine B. The stably integrated cells (ARAF) were trypsinized and resuspended in Opti-MEM 1 supplemented with 2% fetal bovine serum, 1% L- Glutamine, 50  $\mu\text{g}/\text{ml}$  Gentamicine and 1% Pen/Strep. The cells were counted in a Birch chamber and diluted to a concentration

of 100 000 cells /ml. The cells were then seeded out in 384 plates, 5000cells/well in 50µl seeding media and incubated overnight in 37 C, 5% CO<sub>2</sub>.

5 The next day, the seeding medium was removed from the cells and 20 µl induction media (Opti-MEM 1 supplemented with 1% L- Glutamine, 50 µg/ml Gentamicine and 1% Pen/Strep) +/- 0.1 nM Mibolerone was added to the wells. 10µl of test compound diluted in induction media was then added to the wells. The cells were incubated 48 hr in 37 C, 5% CO<sub>2</sub>.

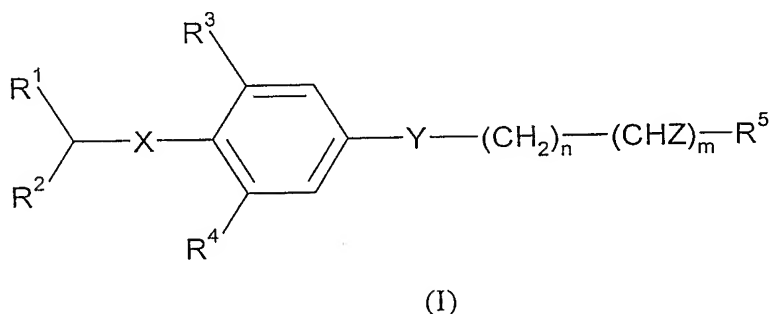
10 After 48 hr 5µl of cell medium was added to white 384 plates with 100µl of ALP substrate buffer. The plates were incubated in 37 C for 20 minutes followed by incubation at room temperature for 10 minutes before each well was read in a µBETA machine. Agonist activity was calculated from the alkaline phosphatase activity induced in the absence of Mibolerone and compared to standard activation curve generated by  
15 Mibolerone alone. Antagonist activity was calculated from the decrease in ALP activity in the presence of 0.1 nM Mibolerone. EC<sub>50</sub> and IC<sub>50</sub> values were calculated by using a non-linear four-parameter fit as described above.

20 Compounds of the invention were found to exhibit binding affinities to the AR receptor in the range of from 40nM to 10000nM.

Other assays to determine androgen receptor mediated activity of the test compounds include modulation of endogenous AR mediated transcription in cell culture systems; modulation of androgen responsive tissue effects in rodents; identification of receptor  
25 surface conformation changes; and binding specificity to AR versus other nuclear receptors.

# Claims

1. A compound of formula (I) or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt, for use in the treatment or prophylaxis of a condition mediated by an androgen receptor,



wherein:

- $R^1$  is selected from  $C_{5-10}$  aryl,  $C(O)-C_{5-10}$  aryl,  $C(O)-C_{3-8}$  heterocyclyl,  $C_{5-10}$  ar- $C_{1-2}$  alkyl,  $C_{3-10}$  heterocyclyl,  $C_{3-10}$  heterocyclyl- $C_{1-2}$  alkyl,  $C_{3-15}$  alkyl,  $C_{4-15}$  alkenyl,  $C_{3-15}$  alkynyl,  $C_{3-10}$  cycloalkyl and  $C_{3-10}$ cycloalkyl $C_{1-2}$ alkyl, said alkyl, alkenyl and alkynyl optionally being substituted with, where applicable, 1 to 3 groups  $R^a$  which may be the same or different; said aralkyl, heterocyclyl and cycloalkyl optionally being substituted with, where applicable, 1 to 3 groups  $R^{a'}$  which may be the same or different; said aryl optionally being substituted with, where applicable, 1 to 4 groups  $R^{a''}$  which may be the same or different;

$R^2$  is selected from hydrogen,  $C_{1-4}$  alkyl,  $C_{2-4}$  alkenyl,  $C_{2-4}$  alkynyl and  $C_{1-4}$  alkoxy;

or  $R^1$  and  $R^2$  together with the carbon atom to which they are both attached form a  $C_{4-8}$  cycloalkyl,  $C_{4-8}$  cycloalkenyl, a saturated or partially saturated  $C_{3-10}$  heterocyclyl,

- optionally substituted with, where applicable, 1 to 3 groups  $R^a$  which may be the same or different;

X is selected from CH<sub>2</sub>, oxygen, sulfur, sulfoxide, sulfone, selenium, tellurium, disulfide, and a group of formula -N(R<sup>c</sup>)-;

5 R<sup>3</sup> and R<sup>4</sup> are independently selected from hydrogen, halogen, C<sub>1-4</sub> alkyl, C<sub>3-7</sub> cycloalkyl, C<sub>3-7</sub> heterocyclyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub> alkynyl, C<sub>1-4</sub> alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio, and COOR<sup>c</sup>;

10 Y is selected from bond, carbonyl, oxygen, sulphur, -CH(R<sup>b</sup>)-, -NHCO-, -NHSO<sub>2</sub>-, -SO<sub>2</sub>NH-, -N(R<sup>c</sup>)- and -CR<sup>6</sup>=CR<sup>7</sup>-;

n is an integer selected from 0, 1, 2 and 3;

15 Z is selected from halogen, amino, hydroxy, mercapto, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub> alkynyl, C<sub>1-4</sub> alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy and (CH<sub>2</sub>)<sub>p</sub>OH, where p is an integer from 1 to 4;

m is an integer selected from 0 and 1;

20

R<sup>5</sup> is selected from -CO<sub>2</sub>R<sup>c</sup>, -PO(OR<sup>c</sup>)<sub>2</sub>, -PO(OR<sup>c</sup>)NH<sub>2</sub>, -SO<sub>2</sub>OR<sup>c</sup>, -COCO<sub>2</sub>R<sup>c</sup>, CONR<sup>c</sup>OR<sup>c</sup>, -SO<sub>2</sub>NHR<sup>c</sup>, -NHSO<sub>2</sub>R<sup>c</sup>, -CONHSO<sub>2</sub>R<sup>c</sup>, and -SO<sub>2</sub>NHCOR<sup>c</sup>;

25 R<sup>6</sup> and R<sup>7</sup> are independently selected from hydrogen, halogen, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub> alkynyl, C<sub>1-4</sub> alkoxy, C<sub>5-10</sub>aryl, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, and (CH<sub>2</sub>)<sub>p</sub>OH, where p is an integer from 1 to 4;

30 R<sup>a</sup> is selected from halogen, C<sub>1-4</sub> alkoxy, C<sub>5-10</sub> aryl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio, mercapto, cyano, and nitro;

$R^{a'}$  is selected from  $R^a$ , fluoromethyl, difluoromethyl, trifluoromethyl,  $C_{1-4}$  alkyl, and  $C_{3-10}$  heterocyclyl- $C_{2-4}$  alkenyl;

5  $R^{a''}$  is selected from:

- $R^{a'}$ ;
- $C_{2-4}$  alkenyl, optionally substituted with 1, 2 or 3 groups selected from  $C_{5-10}$  aryl,  $C(O)R^c$ ,  $C_{3-10}$  heterocyclyl, and  $C_{3-10}$  heterocyclyl substituted with  $C_{1-4}$  alkyl;
- $C_{2-8}$  alkenyloxy;
- 10 -  $C_{3-8}$  cycloalkyl- $C_{1-3}$  alkoxy,  $C_{5-10}$  aryl- $C_{1-3}$  alkoxy, or  $C_{5-10}$  aryloxy, said  $C_{3-8}$  cycloalkyl- $C_{1-3}$  alkoxy,  $C_{5-10}$  aryl- $C_{1-3}$  alkoxy or  $C_{5-10}$  aryloxy optionally being substituted with 1, 2 or 3 groups selected from  $C_{1-4}$  alkyl, halogen, fluoromethyl, difluoromethyl, trifluoromethyl fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, mercapto, hydroxy, cyano, nitro, a group of formula
- 15  $-N(R^c)_2$  in which the two  $R^c$  groups may be the same or different but not both simultaneously hydrogen;

$R^b$  is selected from hydrogen, halogen, hydroxyl, mercapto,  $C_{1-4}$  alkyl,  $C_{2-4}$  alkenyl,  $C_{2-4}$  alkynyl,  $C_{1-4}$  alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy and  $(CH_2)_pOH$ , where p is an integer from 1 to 4; and

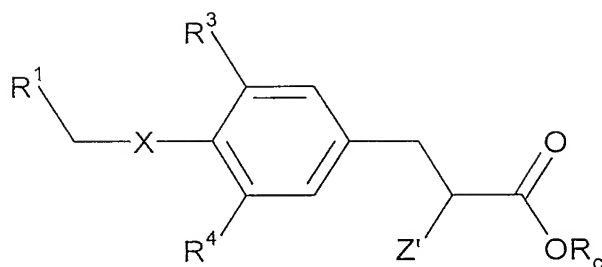
20

$R^c$  is selected from hydrogen,  $C_{1-4}$  alkyl,  $C_{2-4}$  alkenyl and  $C_{2-4}$  alkynyl; and

$R^{c'}$  is selected from  $R^c$ ,  $C_{5-10}$  aryl or  $C_{5-10}$  aryl substituted with amino, hydroxyl, halogen or  $C_{1-4}$  alkyl.

25

2. A compound as claimed in claim 1 which is of formula (Ia) or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt



(Ia)

wherein:

- 5 R<sup>1</sup> is selected from C<sub>6-10</sub> aryl, C<sub>5-10</sub> heterocyclyl-C<sub>1-2</sub>-alkyl, C<sub>4-10</sub> alkyl and C<sub>5-7</sub> cycloalkyl, said alkyl optionally being substituted with, where applicable, 1 to 3 groups R<sup>a</sup> which may be the same or different; said cycloalkyl optionally being substituted with, where applicable, 1 to 3 groups R<sup>a'</sup> which may be the same or different; and said aryl optionally being substituted with, where applicable, 1 to 3 groups R<sup>a''</sup> which may be the same or different;
- 10

X is selected from oxygen and sulfur;

- R<sup>3</sup> and R<sup>4</sup> are independently selected from hydrogen, halogen, C<sub>1-2</sub> alkyl, C<sub>1-2</sub> alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy and trifluoromethoxy;
- 15

Z' is selected from hydrogen, halogen, hydroxyl and mercapto;

- 20 R<sup>a</sup> is selected from halogen, C<sub>5-10</sub>aryl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, nitro, and C<sub>1-4</sub> alkyl or C<sub>2-4</sub> alkenyl substituted with a C<sub>5-10</sub> aryl or a C<sub>5-10</sub> heterocyclyl group;

- R<sup>a'</sup> is selected from R<sup>a</sup>, fluoromethyl, difluoromethyl, trifluoromethyl, C<sub>1-4</sub> alkyl and C<sub>5-10</sub> heterocyclyl-C<sub>2-4</sub> alkenyl;
- 25

R<sup>a''</sup> is selected from:

- $R^{a'}$ ;
- $C_{2-4}$  alkenyl, substituted with  $C_{3-10}$  heterocyclyl;
- $C_{5-10}$  aryloxy, optionally being substituted with 1, 2 or 3 groups selected from  $C_{1-4}$  alkyl, halogen, fluoromethyl, difluoromethyl, trifluoromethyl fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, mercapto, hydroxy, cyano, or nitro;

and

$R^c$  is selected from hydrogen and  $C_{1-4}$  alkyl.

10

3. A compound as claimed in claim 1 or claim 2 whereby the condition mediated by an androgen receptor is selected from the group consisting of: prostate cancer, cardiovascular disease and psychological abnormalities, male pattern baldness (alopecia), benign prostatic hyperplasia (BPH) and acne, hirutism, amenorrhea, hypogonadism, anemia, defects in spermatogenesis, cachexia, osteoporosis, osteopenia, and muscle wasting.

15

4. A method for the treatment or prophylaxis of a condition in a mammal mediated by an androgen receptor, which comprises administering to the mammal a therapeutically effective amount of a compound of formula (I) as defined in claim 1 or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt.

20

5. Use of a compound of formula (I) as defined in claim 1 or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt, for the manufacture of a medicament for the treatment or prophylaxis of a condition mediated by an androgen receptor.

25

6. A pharmaceutical formulation comprising a compound of formula (I) as defined in claim 1 or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a

30

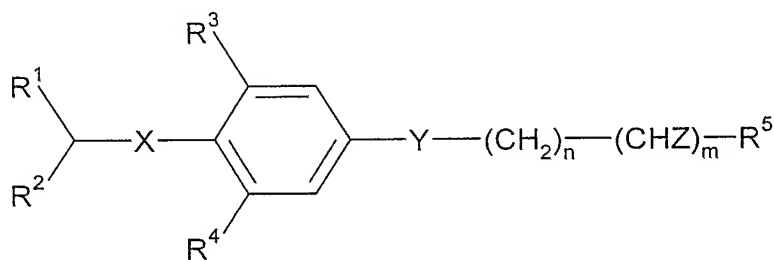


salt of such an ester or amide, and a solvate of such an ester, amide or salt, and a pharmaceutically acceptable excipient.

7. Use of a compound as defined in claim 1 in labelled form as a diagnostic agent for the diagnosis of conditions associated with malfunction of the androgen receptor.

8. Use of a compound as defined in claim 1 or a compound as defined in claim 1 in labelled form, as a reference compound in a method of discovering other ligands of the androgen receptor.

9. A compound of formula (Ib) or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt,



(Ib)

wherein:

$\text{R}^1$  is selected from  $\text{C}_{5-10}$  aryl,  $\text{C}(\text{O})\text{-C}_{5-10}$  aryl,  $\text{C}(\text{O})\text{-C}_{3-8}$  heterocyclyl,  $\text{C}_{5-10}$  ar- $\text{C}_{1-2}$  alkyl,  $\text{C}_{3-10}$  heterocyclyl,  $\text{C}_{3-10}$  heterocyclyl- $\text{C}_{1-2}$  alkyl,  $\text{C}_{3-15}$  alkyl,  $\text{C}_{4-15}$  alkenyl,  $\text{C}_{3-15}$  alkynyl,  $\text{C}_{3-10}$  cycloalkyl and  $\text{C}_{3-10}$ cycloalkyl- $\text{C}_{1-2}$ alkyl, said alkyl, alkenyl and alkynyl optionally being substituted with, where applicable, 1 to 3 groups  $\text{R}^a$  which may be the same or different; said aralkyl, heterocyclyl and cycloalkyl optionally being substituted with, where applicable, 1 to 3 groups  $\text{R}^{a'}$  which may be the same or different; said aryl optionally being substituted with, where applicable, 1 to 4 groups  $\text{R}^{a''}$  which may be the same or different;

$R^2$  is selected from hydrogen,  $C_{1-4}$  alkyl,  $C_{2-4}$  alkenyl,  $C_{2-4}$  alkynyl and  $C_{1-4}$  alkoxy;

- 5 or  $R^1$  and  $R^2$  together with the carbon atom to which they are both attached form a  $C_{4-8}$  cycloalkyl,  $C_{4-8}$  cycloalkenyl, a saturated or partially saturated  $C_{3-10}$  heterocyclyl, optionally substituted with, where applicable, 1 to 3 groups  $R^a$  which may be the same or different;

- 10 X is selected from  $CH_2$ , oxygen, sulfur, sulfoxide, sulfone, selenium, tellurium, disulfide, and a group of formula  $-N(R^c)-$ ;

- 15  $R^3$  and  $R^4$  are independently selected from hydrogen, halogen,  $C_{1-4}$  alkyl,  $C_{3-7}$  cycloalkyl,  $C_{3-7}$  heterocyclyl,  $C_{2-4}$  alkenyl,  $C_{2-4}$  alkynyl,  $C_{1-4}$  alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio, and  $COOR^c$ ;

Y is selected from bond, carbonyl, oxygen, sulphur,  $-CH(R^b)-$ ,  $-NHCO-$ ,  $-NHSO_2-$ ,  $-SO_2NH-$ ,  $-N(R^c)-$  and  $-CR^6=CR^7-$ ;

- 20 n is an integer selected from 0, 1, 2 and 3;

- 25 Z is selected from halogen, amino, hydroxy, mercapto,  $C_{1-4}$  alkyl,  $C_{2-4}$  alkenyl,  $C_{2-4}$  alkynyl,  $C_{1-4}$  alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy and  $(CH_2)_pOH$ , where p is an integer from 1 to 4;

$R^5$  is selected from  $-CO_2R^c$ ,  $-PO(OR^c)_2$ ,  $-PO(OR^c)NH_2$ ,  $-SO_2OR^c$ ,  $-COCO_2R^c$ ,  $CONR^cOR^c$ ,  $-SO_2NHR^c$ ,  $-NHSO_2R^c$ ,  $-CONHSO_2R^c$ , and  $-SO_2NHCOR^c$ ;

- 30  $R^6$  and  $R^7$  are independently selected from hydrogen, halogen,  $C_{1-4}$  alkyl,  $C_{2-4}$  alkenyl,  $C_{2-4}$  alkynyl,  $C_{1-4}$  alkoxy,  $C_{5-10}$ aryl, fluoromethyl, difluoromethyl, trifluoromethyl,

fluoromethoxy, difluoromethoxy, trifluoromethoxy, and  $(\text{CH}_2)_p\text{OH}$ , where p is an integer from 1 to 4;

5  $\text{R}^a$  is selected from halogen,  $\text{C}_{1-4}$  alkoxy,  $\text{C}_{5-10}$  aryl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio, mercapto, cyano, and nitro;

10  $\text{R}^{a'}$  is selected from  $\text{R}^a$ , fluoromethyl, difluoromethyl, trifluoromethyl,  $\text{C}_{1-4}$  alkyl, and  $\text{C}_{3-10}$  heterocyclyl- $\text{C}_{2-4}$  alkenyl;

$\text{R}^{a''}$  is selected from:

- $\text{R}^{a'}$ ;
- $\text{C}_{2-4}$  alkenyl, optionally substituted with 1, 2 or 3 groups selected from  $\text{C}_{5-10}$  aryl,  $\text{C}(\text{O})\text{R}^c$ ,  $\text{C}_{3-10}$  heterocyclyl, and  $\text{C}_{3-10}$  heterocyclyl substituted with  $\text{C}_{1-4}$  alkyl;
- 15 -  $\text{C}_{2-8}$  alkenyloxy;
- $\text{C}_{3-8}$  cycloalkyl- $\text{C}_{1-3}$  alkoxy,  $\text{C}_{5-10}$  aryl- $\text{C}_{1-3}$  alkoxy, or  $\text{C}_{5-10}$  aryloxy, said  $\text{C}_{3-8}$  cycloalkyl- $\text{C}_{1-3}$  alkoxy,  $\text{C}_{5-10}$  aryl- $\text{C}_{1-3}$  alkoxy or  $\text{C}_{5-10}$  aryloxy optionally being substituted with 1, 2 or 3 groups selected from  $\text{C}_{1-4}$  alkyl, halogen, fluoromethyl, difluoromethyl, trifluoromethyl fluoromethoxy, difluoromethoxy,
- 20 trifluoromethoxy, methylthio, mercapto, hydroxy, cyano, nitro, a group of formula  $-\text{N}(\text{R}^c)_2$  in which the two  $\text{R}^c$  groups may be the same or different but not both simultaneously hydrogen;

25  $\text{R}^b$  is selected from hydrogen, halogen, hydroxyl, mercapto,  $\text{C}_{1-4}$  alkyl,  $\text{C}_{2-4}$  alkenyl,  $\text{C}_{2-4}$  alkynyl,  $\text{C}_{1-4}$  alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy and  $(\text{CH}_2)_p\text{OH}$ , where p is an integer from 1 to 4; and

$\text{R}^c$  is selected from hydrogen,  $\text{C}_{1-4}$  alkyl,  $\text{C}_{2-4}$  alkenyl and  $\text{C}_{2-4}$  alkynyl;

30  $\text{R}^c$  is selected from  $\text{R}^c$ ,  $\text{C}_{5-10}$  aryl or  $\text{C}_{5-10}$  aryl substituted with amino, hydroxyl, halogen or  $\text{C}_{1-4}$  alkyl; and

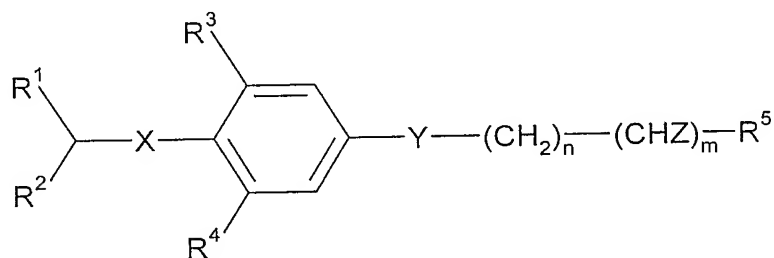
m is 1; or

simultaneously m is 0 or 1 and R<sup>3</sup> is C<sub>3-7</sub> heterocyclyl; or

simultaneously Y is bond, m is 0, n is 0 and R<sup>5</sup> is -CO<sub>2</sub>R<sup>c</sup>.

5

10. A compound of formula (Ic) or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of such an ester, amide or salt,



10

(Ic)

wherein:

R<sup>1</sup> is selected from C<sub>5-10</sub> aryl, C(O)-C<sub>5-10</sub> aryl, C(O)-C<sub>3-8</sub> heterocyclyl or C<sub>5-10</sub> heterocyclyl-C<sub>1-2</sub> alkyl,

15 - said C(O)-C<sub>5-10</sub> aryl, C(O)-C<sub>3-8</sub> heterocyclyl or C<sub>5-10</sub> heterocyclyl-C<sub>1-2</sub> alkyl optionally being substituted with, where applicable, 1 to 3 groups R<sup>a</sup> which may be the same or different;

- said C<sub>5-10</sub> aryl being substituted with a group selected from:

- C<sub>5-10</sub> aryl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, mercapto, fluoromethyl, difluoromethyl, and C<sub>3-10</sub> heterocyclyl-C<sub>2-4</sub> alkenyl;
- 20 - C<sub>2-4</sub> alkenyl, substituted with 1, 2 or 3 groups selected from C<sub>5-10</sub> aryl, C(O)R<sup>c</sup>, C<sub>3-10</sub> heterocyclyl, and C<sub>3-10</sub> heterocyclyl substituted with C<sub>1-4</sub> alkyl;
- C<sub>2-8</sub> alkenyloxy;
- C<sub>3-8</sub> cycloalkyl-C<sub>1-3</sub> alkoxy, C<sub>5-10</sub> aryl-C<sub>1-3</sub> alkoxy, or C<sub>5-10</sub> aryloxy, said C<sub>3-8</sub> cycloalkyl-C<sub>1-3</sub> alkoxy, C<sub>5-10</sub> aryl-C<sub>1-3</sub> alkoxy or C<sub>5-10</sub> aryloxy optionally being
- 25 substituted with 1, 2 or 3 groups selected from C<sub>1-4</sub> alkyl, halogen, fluoromethyl, difluoromethyl, trifluoromethyl fluoromethoxy, difluoromethoxy,

trifluoromethoxy, methylthio, mercapto, hydroxy, cyano, nitro, a group of formula  $-N(R^c)_2$  in which the two  $R^c$  groups may be the same or different but not both simultaneously hydrogen;

5 - said aryl optionally also substituted with, where applicable, 1 to 2 groups  $R_{a'}$  which may be the same or different,

$R^2$  is selected from hydrogen,  $C_{1-4}$  alkyl,  $C_{2-4}$  alkenyl,  $C_{2-4}$  alkynyl and  $C_{1-4}$  alkoxy;

10 X is selected from  $CH_2$ , oxygen, sulfur, sulfoxide, sulfone, selenium, tellurium, disulfide, and a group of formula  $-N(R^c)-$ ;

15  $R^3$  and  $R^4$  are independently selected from hydrogen, halogen,  $C_{1-4}$  alkyl,  $C_{3-7}$  cycloalkyl,  $C_{3-7}$  heterocyclyl,  $C_{2-4}$  alkenyl,  $C_{2-4}$  alkynyl,  $C_{1-4}$  alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio, and  $COOR^c$ ;

Y is selected from bond, carbonyl, oxygen, sulphur,  $-CH(R^b)-$ ,  $-NHCO-$ ,  $-NHSO_2-$ ,  $-SO_2NH-$ ,  $-N(R^c)-$  and  $-CR^6=CR^7-$ ;

20 n is an integer selected from 0, 1, 2 and 3;

Z is selected from halogen, amino, hydroxy, mercapto,  $C_{1-4}$  alkyl,  $C_{2-4}$  alkenyl,  $C_{2-4}$  alkynyl,  $C_{1-4}$  alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy and  $(CH_2)_pOH$ , where p is an integer from 1 to 4;

25

m is an integer selected from 0 and 1;

$R^5$  is selected from  $-CO_2R^c$ ,  $-PO(OR^c)_2$ ,  $-PO(OR^c)NH_2$ ,  $-SO_2OR^c$ ,  $-COCO_2R^c$ ,  $CONR^cOR^c$ ,  $-SO_2NHR^c$ ,  $-NHSO_2R^c$ ,  $-CONHSO_2R^c$ , and  $-SO_2NHCOR^c$ ;

30

R<sup>6</sup> and R<sup>7</sup> are independently selected from hydrogen, halogen, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub> alkynyl, C<sub>1-4</sub> alkoxy, C<sub>5-10</sub> aryl, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, and (CH<sub>2</sub>)<sub>p</sub>OH, where p is an integer from 1 to 4;

5

R<sup>a</sup> is selected from halogen, C<sub>1-4</sub> alkoxy, C<sub>5-10</sub> aryl, fluoromethoxy, difluoromethoxy, trifluoromethoxy, methylthio, fluoromethylthio, difluoromethylthio, trifluoromethylthio, mercapto, cyano, and nitro;

10 R<sup>a'</sup> is selected from R<sup>a</sup>, fluoromethyl, difluoromethyl, trifluoromethyl, C<sub>1-4</sub> alkyl, and C<sub>3-10</sub> heterocyclyl-C<sub>2-4</sub> alkenyl;

R<sup>b</sup> is selected from hydrogen, halogen, hydroxyl, mercapto, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl, C<sub>2-4</sub> alkynyl, C<sub>1-4</sub> alkoxy, fluoromethyl, difluoromethyl, trifluoromethyl, fluoromethoxy, difluoromethoxy, trifluoromethoxy and (CH<sub>2</sub>)<sub>p</sub>OH, where p is an integer from 1 to 4; and

15

R<sup>c</sup> is selected from hydrogen, C<sub>1-4</sub> alkyl, C<sub>2-4</sub> alkenyl and C<sub>2-4</sub> alkynyl; and

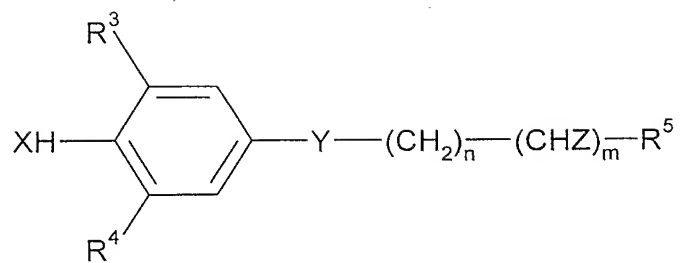
R<sup>c'</sup> is selected from R<sup>c</sup>, C<sub>5-10</sub> aryl or C<sub>5-10</sub> aryl substituted with amino, hydroxyl, halogen or C<sub>1-4</sub> alkyl.

20

11. A compound as claimed in claim 9 or 10 for use as a medicament.

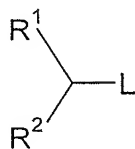
12. A method for preparing a compound of formula (Ib) as described in claim 9 or a compound of formula (Ic) as described in claim 10 comprising a step of adding a compound of formula (II)

25



(II)

wherein  $X$ ,  $R^3$ ,  $R^4$ ,  $Y$ ,  $n$ ,  $Z$ ,  $m$  and  $R^5$  are as defined in claim 9 or 10, with a compound of  
5 formula (III)



(III)

10 wherein  $R^1$  and  $R^2$  are as defined in, as appropriate, claim 9 or 10 and  $L$  is a suitable leaving group, optionally in the presence of a suitable base.

**Abstract**

The invention provides compounds of formula (I) or a pharmaceutically acceptable ester, amide, solvate or salt thereof, including a salt of such an ester or amide, and a solvate of  
5 such an ester, amide or salt, for use in the treatment or prophylaxis of a condition mediated by an androgen receptor.

